POWER

A McGRAW-HILL PUBLICATION—ESTABLISHED 1884
ELY C. HUTCHINSON, *Editor*

Volume 72 NEW YORK, NOVEMBER 11, 1930 *Number 20*

Science in Power

MACHINERY, mechanics, the firing of coal, the making of power—greasy, grimy, homely subjects with which one does not naturally associate the beauties and niceties of science.

Yet out of the crudities of the early stages the application of scientific research and processes has developed a system as wonderful as the beautiful products that the chemist extracts from the coal bin.

Thermodynamics, lagging at first behind accomplished fact, succeeded in explaining the nature of heat and its manifestations and pointed the way to the legitimate processes of converting the potential energy of fuel into useful forms of power.

He who will may now have knowledge of the composition of the fuel which he is burning and by the analysis of the products of its combustion determine with what degree of effectiveness its burning has been effected.

With suitable instruments are determined not only the pressure, temperature and quality of steam, but also the quantity flowing in a given time as well as the air consumed in its production. Running a boiler room has become a white-collar job.

The part that chemistry plays in feed-water treatment and in the prevention of scale and corrosion is too obvious for comment.

Metallurgy has produced strange new substances for which extensive use was waiting, and, to order, materials for special purposes. It and refined processes involving harmonics and dynamic balance have made possible the revolving of turbine, generator, pump and compressor rotors and impellers at velocities that would have staggered the pioneers.

Electricity has vastly extended the field of power by facilitating its distribution and creating new uses and applications for it.

The boiler-maker works now not only with the bending rolls and riveting bull, but with the strain gage and the extensometer, and X-ray and resistance and reluctance indications permit of the exploration of the interior of welded joints and of testing the soundness of castings and other masses of metal.

My space is all too short to more than direct attention to the growing part that scientific apparatus and methods are playing in the field of power. I leave the thought with you.

EDITORIALS

Power Explorations

IN EVERY FIELD are a few intrepid souls who break away from the normal routine and strike out into the unknown. These are men who combine an immense curiosity with the zest and the courage for adventure. More often than not they pioneer simply because it is their nature to do so—because they like it. But they deserve the moral support of all mankind, because their work is essential to the world's progress.

This is as true of the power field as of others. The average engineer finds it necessary to confine his efforts to undertakings where ultimate success is reasonably certain. But now, as in the past, certain brilliant minds in the power field have felt the creative urge, and have found it possible to follow their instincts. Their work, in the aggregate, is comparable with that of research leaders in biology, physics and chemistry. Faraday is the classic example.

Yet our power argonauts, some of them truly great men, are often compelled to fight nature single handed, without the moral support of power engineers in general. A typical example is Claude's bold plan to tap the heat of tropical seas for power generation. Whether or not he succeeds commercially, such a magnificent attempt, based on scientific knowledge, deserves the utmost respect and consideration.

To take another example, we may not be ready to grant that Barjot's scheme for converting into power the heat of Arctic seas will become commercial in twenty years—or fifty. Yet this plan, likewise founded on natural law, may not be laughed off as utterly foolish.

The proposal to store steam in underground caverns for peak-load use is another interesting product of creative intelligence, and must not be rejected merely because of its strangeness.

Only recently (Oct. 28) *Power* outlined the chemical binary-vapor cycle proposed by Dr. Koenemann of Germany. Here is a break from traditional power practice that may find early commercial application. It deserves careful study.

Beyond these lie other possibilities, still unfathomed. These include ultimate commercial application of the process whereby nature transmutes chemical energy directly into mechanical work in the muscles of animals. Then there is the problem of the direct conversion of heat into electricity on an economical basis. In such fundamental researches will be found opportunities for close co-operation of physicist, biologist, chemist and engineer. And when scientific men undertake studies along these lines they should have the moral support of all power engineers.

It should not be inferred that any of the examples cited—except perhaps the Koenemann cycle and underground steam storage—are practicably promising at the present time. The point is that these efforts exemplify the free play of the imagination on power problems that somewhere and somehow will open new energy fields for the benefit of mankind.

Co-operation Needed In Coal Purchasing

THE BUYING of coal for industrial power plants usually is left to purchasing agents who also purchase what other supplies are required by the manufacturing enterprise. This is good practice only when the advice and co-operation of the power engineer is secured.

All too frequently purchasing agents buy either the cheapest coal available, or an expensive high-heat-value coal, without considering the type of fuel-burning equipment or furnace in which the coal is to be used. Such purchasing results in decreased boiler efficiency and poor dollars-and-cents economy.

By co-operating with the power engineer and arranging with him to run burning tests on samples of available coal a considerable decrease in the fuel bill can be obtained. There are cases where the joint effort of the power engineer and the purchasing agent to obtain a coal with most heat per dollar has resulted in decreases of 25 to 30 per cent in the fuel bill.

Do You Do Or Don't You?

THERE are two kinds of people—those who "do" and those who "don't." Both are still in industry, but the inexorable law of the survival of the fittest is rapidly and relentlessly removing those in the "don't" class. Never has there been a time, like the present, in which this has been so true.

The progressive industries stand out as clearly as though labeled. Their organizations are imbued with advanced ideas. They have programs with definite objectives looking, not one, but many years ahead. They take into account the changed conditions of business, and order getting, and the necessity of producing equipment that will have appeal to logical minds. Purchasers in this clear-thinking, dominant group are, in turn, bent upon using only that apparatus which will function according to the modern requirement for producing goods of better quality at lower cost.

It behooves any industries that may be just floating along until times get better, to get into the "do" class quickly. Let them take stock of their viewpoints and find out where they are going, else they discover their predicament too late.

Economics of Water Power Consistent With Location

CONDITIONS under which water powers are developed vary so widely that no fixed rules can be given for their economic use. In mountainous regions the high heads available are usually distant from load centers, whereas away from high mountains, low and medium heads generally obtain in proximity to centers of power distribution. In regions formerly glaciated, lakes are usually available for daily and seasonal storage, but in other sections artificial storage reservoirs must be provided for seasonal-flow regulation.

In California abundant supplies of oil and gas have slowed up water-power developments, and long distances between load centers and power sites have had a marked effect. On the other hand, in Pennsylvania, close to coal mines, where fuel is cheap, water-power development is very active. In this territory some of the largest hydro plants in this country have been built or are under construction.

On the Susquehanna River power developments are suited to both base-load and peak-load service. They are medium-head run-of-river projects with daily storage at the plants, and are fairly close to large load centers. The plants are built as part of the dams. After the initial development is made, additional capacity can be obtained at the cost of extending the power house only. Where such conditions exist, peak capacity can be obtained at low cost. Sometimes high-head installations involve long flow lines and if additional capacity is installed it requires an extension of these. In addition, long, expensive transmission lines may have to be constructed.

Then again the water storage may be so located that it is not available for immediate use as required in peak-load service.

A run-of-river plant, comparatively close to load centers and developed for peak capacity, can be used in flood periods on the base load to supply a large kilowatt-hour output of low-cost power. During low-water periods the plant supplies peak load and has a large kilowatt output for a short period. Such a plant also has a certain stand-by value to pick up load immediately if another plant fails.

There is nothing inconsistent with economics in the development of any of these projects when local conditions are considered. Factors that influence a development in one region may not exist in another. Consequently, one cannot be used as an economic guide for the other.

Thermal Efficiency And the Cost of Kilowatt-Hours

THERE are few people indeed who do not glory in the pride of accomplishment and experience a sense of righteous satisfaction with a job well done. That engineers and designers of power houses are not exceptions is to their credit. Their work in the laying out, proportioning and selecting equipment, as a general rule, manifests the acme of thermodynamic efficiency.

But what of the dollars? It is one thing to build a plant that will make a kilowatt-hour with the minimum number of B.t.u.s, but sometimes quite another to make a kilowatt-hour with the least expenditure of money. Practical engineering, after all, counts the *quid pro quo* in dollars and cents.

Where fuel is cheap, a judicious sacrifice of efficiency may so reduce capital, operating and maintenance expenses as to actually lower the cost of power at the switchboard.

Although recognition of this idea has already profited many, there is plenty of room for its wider application.

▼

POWER *Stands for . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

▼

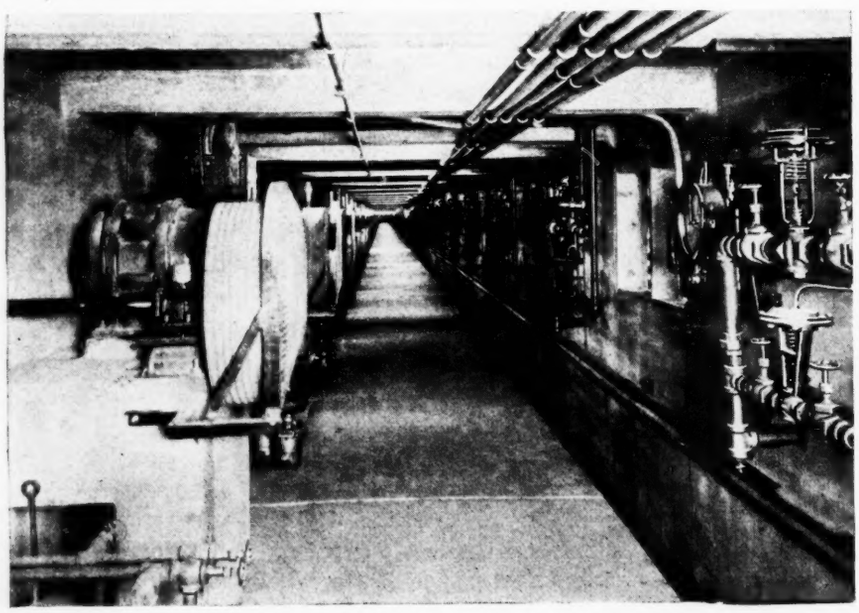
By C. A. SCRIBNER
Engineer
Battey & Kipp, Inc., Chicago

MODERN 4,000-Kw. PLANT Services the Making of PINE LUMBER

Wood refuse is burned in Dutch ovens equipped with horizontal grates. Cheap fuel, a load factor of 60 per cent and few operators make for low production costs

THE Edward Hines Lumber Company recently placed in service a new lumber mill, near Burns, Ore., for the production of Oregon "Pondosa" pine lumber. It is of modern design throughout, employing straight-line production methods now so generally applied in well-designed factories. This mill is built to saw, kiln-dry, surface and ship 400,000 ft. of lumber per eighteen-hour day, and includes a sawmill, dry kilns, a planing mill and all departments upon which these three main subdivisions of the mill depend. A new town of Hines, with a population of about 1,000 people, has been built near the mill for housing the employees.

Logging operations have the town of Seneca, 50 miles from Burns, as headquarters. At Seneca is the terminal of a 50-mile steam railroad which operates between the two towns. All logs are consolidated on cars at Seneca and shipped by train to Burns, where they are delivered to the mill site and emptied into an artificial 40-acre log pond. Finished kiln-dried lumber is shipped out. All services for the mill, such as water, steam, compressed air and electricity, are provided from an isolated power plant, which also supplies the new town.

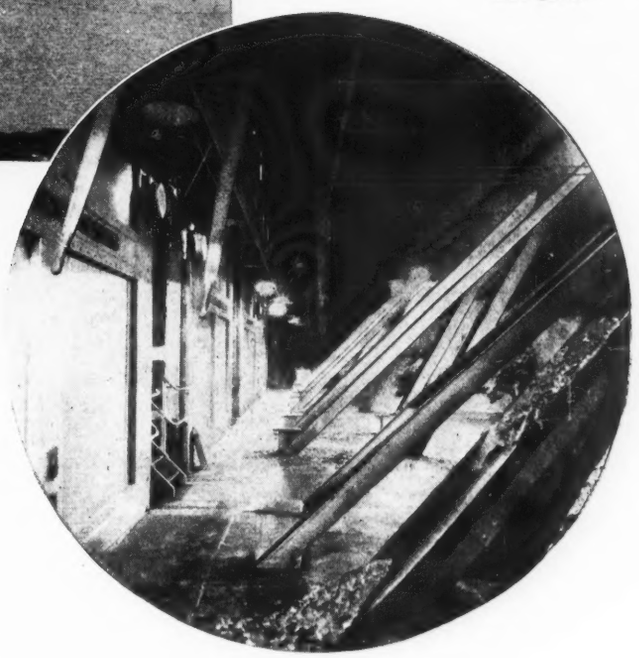


Dry kiln operating tunnel. At the right are the thermostatic and humidity controls. Fan motors and drives appear at the left

Prior to the acquisition of the property by the Hines Lumber Company, a few of the buildings had been constructed, among them concrete boiler and turbine houses designed and built for four 6,000-sq.ft. boilers in two batteries and two 2,000-kw. turbine-generators with the necessary auxiliaries.

A careful analysis of the mill and town requirements by the engineers for the Hines interests indicated a maximum steam demand of 140,000 lb. per hour and an electric demand of 3,000 kw. The installation consists of four 8,000-sq.ft. boilers, two 3,000-kw. turbine-generators, two 500-cu.ft.-per-minute steam-driven air compressors and the necessary

New Hines Lumber Mill near Burns, Oregon. Note log pond in foreground and flood lighting towers near mill buildings



Firing aisle of boiler room, showing roof of furnaces, fuel chutes and gates

pumping equipment. To install these larger boiler and generator units without crowding, all boiler room auxiliaries were placed in an extension to the original boiler room and all fire and general service pumps in a separate pump room near the water intake.

Water is required for fire protection, for keeping the proper level in the log pond, for condensing water, drinking water, log washing, general service and boiler make-up. The log pond is adequately supplied by a warm spring at the southwest corner of the pond. Normal flow from the spring is 1,000 gal. per minute, but this has been increased by the installation of a motor-driven centrifugal pump which lowers the head on the spring and thus increases the flow. Two motor-driven 1,000-gal. pumps have been installed in two 12-in. deepwells. Water from these wells is from the same strata as the spring water, so the temperature and physical properties are similar. Discharge from the two wells is delivered to the suction of the fire pumps to the boiler and turbine rooms, or to the pond.

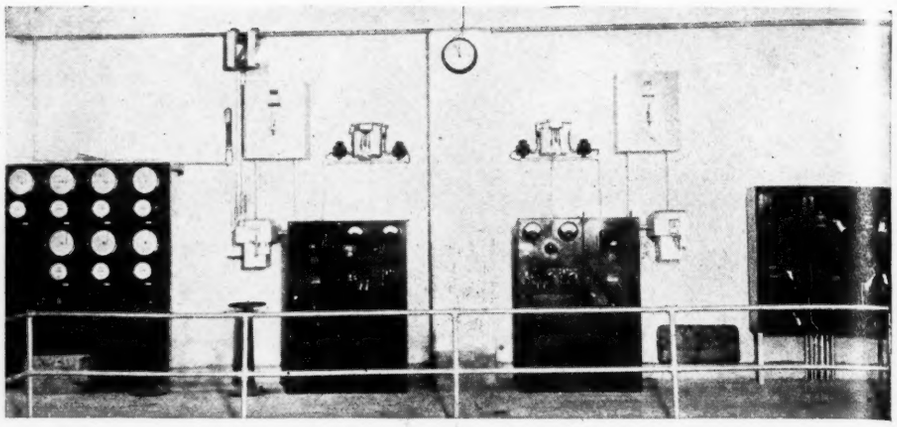
A water intake with trash rack and screens is located at the northeast corner of the pond. In the pump house adjoining are two 1,000-gal. Underwriters steam pumps, two 1,500-gal. Underwriters motor-driven centrifugal fire pumps, one of the deepwell pumps, a pump for supplying water for log washing, an automatic general service water pumping outfit and a drinking water pump and cooler. All take suction from the wells. The fire pumps and log wash pumps also have suction connection to the sump beneath the pump house, which is supplied from the pond through a screened intake. A 16-in. suction line to the condenser circulating pumps also originates at this sump, and continues to the turbine room submerged below the water level in the sump and pond for the greater part of the distance.

Having passed through the condensers, the cooling water is returned by gravity to the opposite end of the pond through an open flume, the pond and flume thus acting as the cooling area. The outlet of the pond is near the flume, so any surplus water allowed to escape from the pond is the warmer water from the condensers. During the winter period all or any part of the condensing water may be discharged to the pond near the log haul. This, together with sawmill exhaust, keeps the pond free of ice at this point.

Well water is suitable for drinking, but its temperature leaving the wells is 75 deg. F., requiring a cooling system for this service. All of the buildings are completely equipped with fire-protection apparatus, requiring a 200,000-gal. overhead storage tank, four fire pumps, twenty miles of underground piping and 20,000 sprinkler heads. Most of the buildings are not heated, which necessitated a dry pipe system operated on compressed air. The air compressors are in the turbine-room basement and supply compressed air at 90 lb. pressure to the sprinkler system and to air hoists and other equipment.

Steam is needed for the operation of the turbine-generators, for the shot gun feeds, niggers and other equipment in the saw mill, for the 40 dry kilns, for the steam-driven air compressors, steam fire pumps and for some heating. The dry kilns, using about 60,000 lb. of steam per hour, and the sawmill equipment, with a demand of 12,000 to 15,000 lb., are operated at 125 lb. pressure. Steam to the heating coils in each kiln is varied from 0 to 125 lb. pressure by automatic thermostatic valves, the pressure depending upon the heat requirements of the lumber during its four-day period of conditioning. The air compressors and fire pumps also require steam at 125 lb. pressure, while the various sections of the heating system are served with steam at from 0 to 120 lb. pressure. The only portions of

the plant which are heated are the office building, which operates on 5 lb. pressure through reducing valves; the saw mill building, on 1 lb. pressure from shot gun feed exhaust or through reducing valves; two small service buildings, the oil house, and the filing room in the planing mill, which are heated with steam at 125 lb. All condensation is returned to the boiler room except the exhaust from the sawmill rigs, air compressors, fire pumps and live steam spray in the dry kilns. The returns from dry kiln coils and the office building are pumped back, while the remainder of the condensation is returned by traps. Before specifications for equipment were written, an interesting analysis was made of the various factors involved to determine the most economical pressure at which the boilers were to be operated and the type of turbines to be installed. The factors most affecting this decision and the selection of type of turbine and water treatment were: Wood refuse was to be made far beyond its economical uses, which include fuel for the power plant boilers, fuel for the boilers at Seneca, and sale to local domestic customers for heating homes; first cost of equipment for the various types, pressures and temperatures considered; station heat balance, which was, in turn, influenced by the method of water treatment; simplicity in design and operation; need for means to keep the log pond open throughout the winter when the temperature reaches 50 deg. below zero; and the size and arrangement of buildings already constructed.

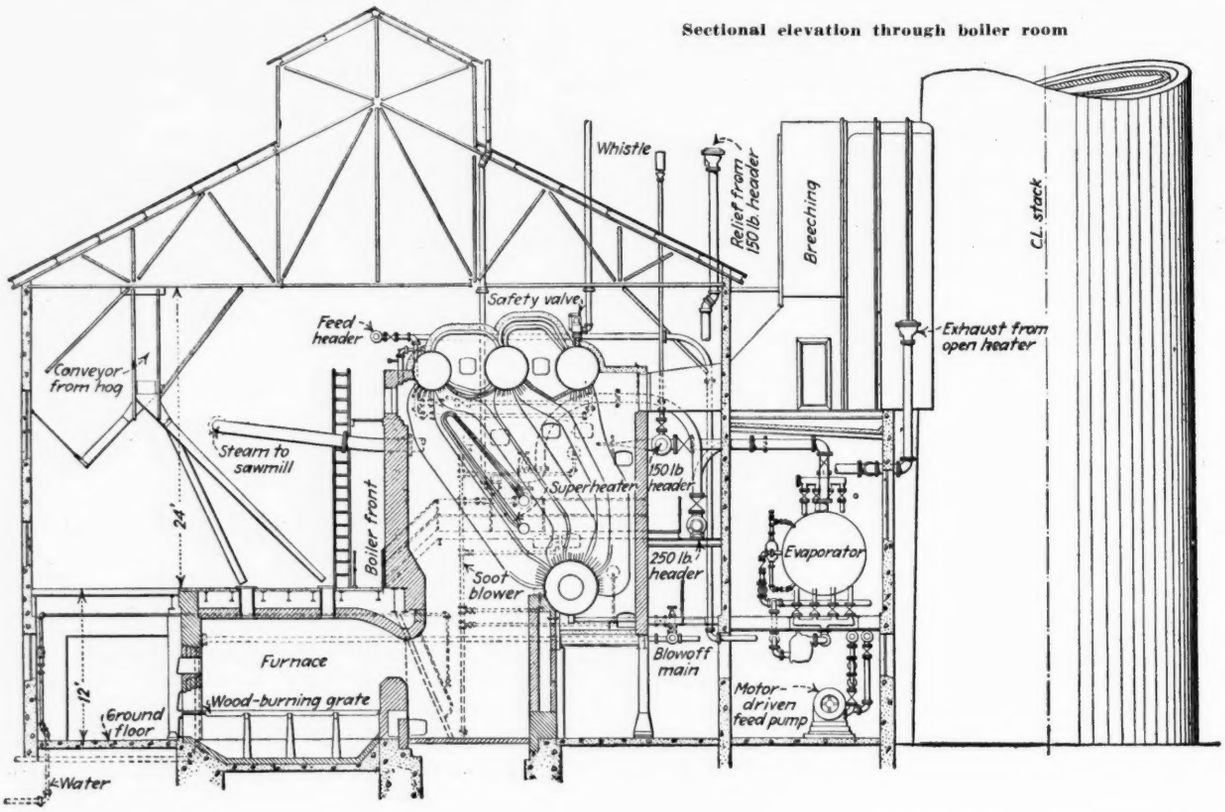


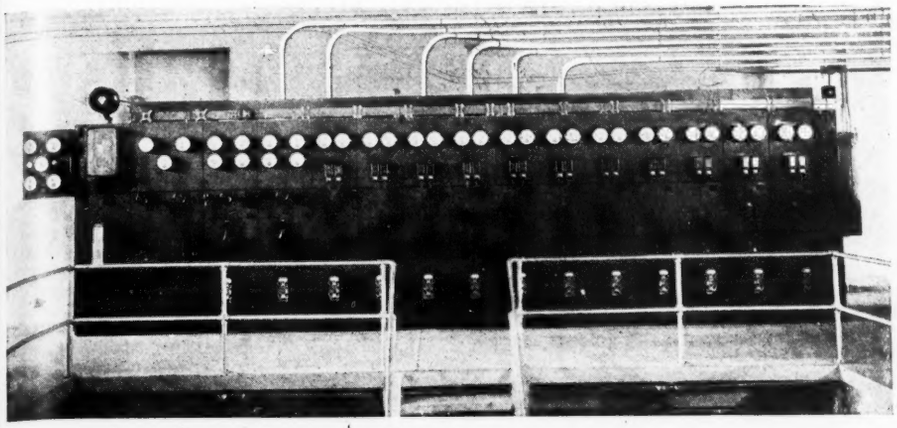
Flow meters and motor starting and protection panels in the turbine room

A steam pressure of 245 to 250 lb. on the boilers was found to be the most economical. Four 8,000-sq.ft. Stirling-type boilers were installed, with convection-type superheaters, to generate steam at a final temperature of 550 deg. F. The boilers are of the single-pass type, so baffled that the gases flow directly across the various tube banks from the combustion chamber to the rear of the setting. Special baffle tile on several rows of tubes are staggered to effect a tortuous flow of the gases, thus providing for the proper heat transfer and at the same time keeping down the draft loss through the boilers. This was particularly desirable because of the comparatively large volume of gases passing to the chimney and because the plant is 4,400 ft. above sea level. This type of baffling made a material saving in the size of the chimney.

Suspended flat arch construction is used over the furnace and air-cooled walls in the sides of the combustion chamber, with ports for admission of air at the proper points. Boilers are set singly, with the mud drums 12 ft. above the floor line and are provided with Dutch ovens 16x16 ft. in plan and 14 ft. high. Each furnace has four feed pots in the roof, fed by spouts from an overhead chain fuel conveyor that brings the hogged fuel direct

Sectional elevation through boiler room





Main instrument and control switchboard

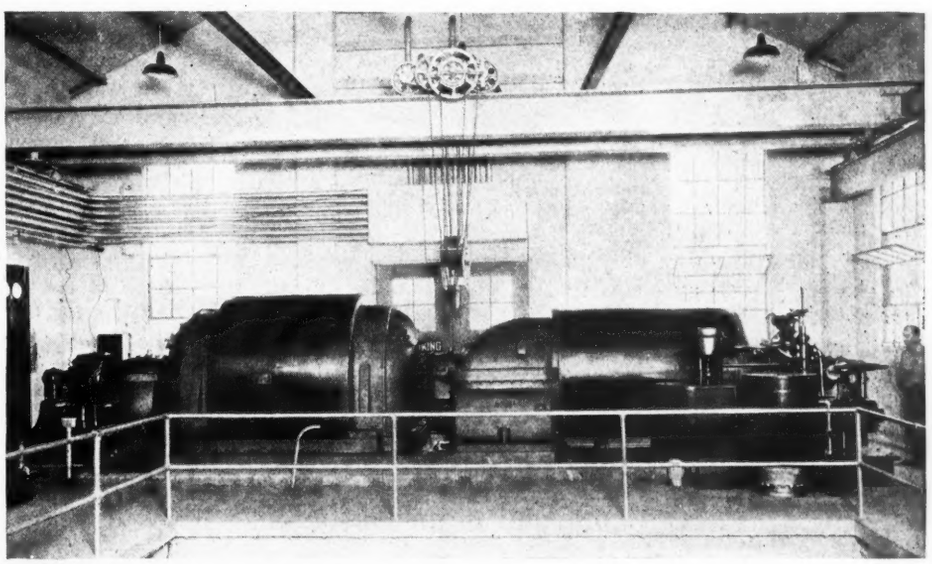
from the sawmill. This wood refuse can be carried through the boiler room to the fuel house, where it is stored, together with dry shavings from the planing mill. At the boiler room operator's option, fuel can be delivered by the conveyor system from the fuel house or the saw mill.

As the quantity of hogged wood refuse and shavings from the planing mill is considerably in excess of that required by the boilers, and because of the distance such refuse must be transported by rail to find a market, it was necessary to erect a separate refuse burner to dispose of the excess.

Each boiler and furnace is guaranteed to deliver 69,000 lb. of steam per hour from and at 212 deg. F., equivalent to 250 per cent of boiler rating, although 200 per cent rating is the anticipated maximum. The four boilers, with aisles and firing space for efficient operation, occupy the entire space provided in the original boiler room. The auxiliaries, in the annex of the boiler room, consist of the boiler feed pump, make-up pumps, evaporator, hotwell and clear-water storage tanks and feed-water heater. Flue gas from the boilers is collected into a main breeching which discharges into a concrete chimney 250 ft. high and 16 ft. in diameter.

An analysis of the water supply showed a great need for water treatment. After a careful analysis of all possible methods of purification the evaporator system was selected. The evaporator is of the pressure-reducing type, operating between 250 and 130 lb. pressure. Steam at 250 lb. and 550 deg. total temperature is condensed in the evaporator, heat loss from this transfer being taken up by the raw make-up water and saturated steam produced at 130 lb. pressure. The evaporator supplies just enough 130 lb. steam to make up for what is discharged to the atmosphere from the shot gun feeds, air compressors, the live steam spray at the dry kilns and other losses.

Under normal operating conditions all make-up water for the boilers is delivered to an open feed-water heater, where a large portion of the solids is precipitated. Discharge from the heater is delivered by steam-driven pumps to the evaporator. Condensation from the evaporator and from all other steam-using equipment throughout the mill except that from the turbines is discharged into a hotwell tank from which the boiler-feed pumps take their supply. Turbine condensate is pumped into a clear-water tank located beside the hotwell, this tank serving as the fluctuating supply to the hotwell. Water from the clear-water tank is pumped into the hotwell through a balanced float valve as the hotwell requires additional water. When the clear-water tank is nearly full a float operates a remotely controlled balanced valve on the high-pressure steam line to the evaporator, partly closing it and thus decreasing the quantity of 130-lb. steam made by the evaporator and the condensation from this source. This depletes the hot-water supply to the hotwell tank until the float valve operates and water flows to the hotwell from the clear-water tank, causing the first-mentioned float to fall again and increase the steam supply to the evaporator. To keep a balance on the system the evaporator is operated in parallel with pressure-reducing valves.



One of the two 3,000-kw., 2,300-volt turbine-generator units installed

The hotwell tank receiving condensation from all sources has a final temperature well above that of saturated steam at atmospheric pressure. The hotwell is vented to the open feed-water heater, pressure on which is carried at from 2 to 5 lb. As seen from the heat balance chart, under normal operating conditions, the amount of flash steam from the hotwell is sufficient to heat all the make-up water to 220 deg. No exhaust from the air compressors or other steam-driven apparatus is used to heat feed water unless the pressure in the hotwell drops below 2 lb., in which case, by an arrangement of non-return valve and atmospheric relief, the air compressor and make-up pump drives exhaust to the heater.

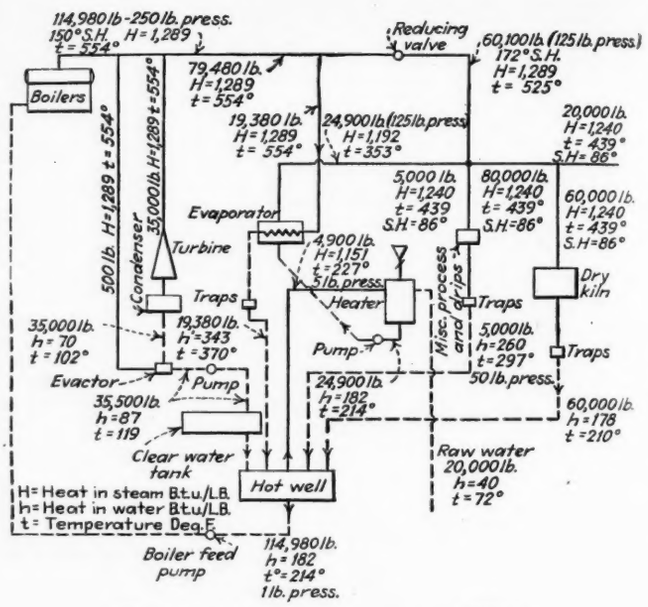
Two horizontal, reaction-type, 3,000-kw. turbine-gene-

rators equipped with two-pass surface condensers supply the electrical load. Exciters are mounted on the generator shafts. Circulating and condensate pumps are in the basement of the turbine room. The generators are equipped with a closed system of air supply, and the turbines with an oil-filtering equipment. A 15-ton hand-power traveling crane is provided in the turbine room. A well has been left in the turbine room floor for handling equipment to the basement and also as a means for providing light to the lower elevation. Current is generated at 2,300 volts and supplied directly for all motors over 50 hp. and through outdoor transformer stations for smaller 440-volt motors and for lighting at 220-110 volts.

Some of the large motors, such as those for condenser circulating water pumps, boiler feed pumps, band mills, shaving exhaust fans and other equipment, are of the synchronous type and each is equipped with an individual exciter.

There are three main substations for power distribution, one to serve the sawmill and adjacent buildings, one for the dry kilns and one for the planing mill. There are also three smaller substations at outlying points. Lighting is supplied directly from lighting transformers located on poles at convenient points. The entire mill site is adequately illuminated by flood-light towers. One 2,300-volt circuit from the switchboard supplies current to the town of Hines.

The entire lumber mill and power plant was built, machinery installed and placed in production eight months after work was started. Shortly after the mill was in operation the engineers made tests on the various generating and power equipment to check up on the manufacturers' guarantees and on the preliminary estimates, which were found to be remarkably close to the actual requirements. By means of the tests an annual power production curve was worked out and rates were determined under varying weekly lumber production schedules, to charge the various departments for steam and electricity. Each department is provided with steam-flow and watt-hour meters. It was found that charges, which include the cost of money, taxes, insurance, depreciation, supplies and all other items entering into the cost of power, were extremely low. The fuel cost includes only



Plant heat balance for average conditions

the labor and investment charges for the preparation and transportation of the fuel to the boilers. Cheap fuel is one of the primary reasons for the low production costs. Other items helping to keep this cost down are an annual load factor of 60 per cent and the small number of operators required, there being but one man in the turbine room, one water tender, two firemen and one man in the fuel house each twelve-hour shift.

Design and construction of the entire project was performed under the direction of Edward Hines, president of the Edward Hines Western Pine Company, Chicago; M. H. Hudson, vice-president; and F. W. Pettibone, general manager, who consulted freely with the heads of the various Hines interests throughout the country.

Except for the original boiler and turbine room structures, the power plant and all steam, air, water and electrical service systems were designed and installed by Battey & Kipp., Inc., of Chicago, who also built the entire mill and installed the machinery and equipment.

Power Equipment in the New Mill of Edward Hines Western Pine Co.

Boiler Equipment

Boilers, four, Stirling, water-tube, 7,990 sq.ft. each, 250 lb. pressure, 69,000 lb. steam per hr. at 250 per cent rating, Babcock & Wilcox Co.
Furnaces, four, Dutch oven, grates 217.5 sq.ft. each, Babcock & Wilcox Co.
Furnace walls, ventilated ..... M. H. Detrick Co.
Superheaters, four, two-loop, convection-type, 150 deg. at 200 per cent rating ..... Babcock & Wilcox Co.
Settings ..... National Power Const. Co.
Breeching, steel ..... Colby Steel & Engr. Co.
Stack, one, concrete, 16x256 ft. ..... The Heine Chimney Co.
Soot blowers, four, valve-in-head .. Diamond Power Specialty Corp.
Feed-water regulators, four (Copes) .... Northern Equipment Co.
Blowoff valves ..... Everlasting Valve Co.
Safety valves ..... Ashton Valve Co.
Water columns ..... Reliance Gauge Column Co.
Non-return valves ..... Schutte & Koerting Co.
Flow meters ..... Republic Flow Meters Co.
Recording pressure gages ..... Bristol Co.
Recording thermometers ..... Bristol Co.

Feed-Water Treating and Heating

Heater, one, open, 35,000 lb. per hour, Milwaukee Reliance Boiler Works
Evaporator, one, single-effect, horizontal ..... Griscom-Russell Co.
Clear-water tank, one, 84 in. x 14 ft. .. Steel Tank & Products Corp.
Hotwell tank, one 84 in. x 14 ft. ..... Steel Tank & Products Corp.

Boiler-Feed and Service Pumps

Boiler-feed pumps, two, 4 stage, centrifugal, motor driven, 125 hp., 1,800 r.p.m., 350 g.p.m. .. Worthington Pump & Mach. Corp.
Deepwell pumps, two, 1,000 g.p.m., 1,800 r.p.m.; 75-ft. head, Worthington Pump & Mach. Corp.
Evaporation make-up pumps, two, 12x6x12 in., 100 g.p.m., plunger type ..... American Steam Pump Co.
Hotwell pumps, two, 160 g.p.m., 3,600 r.p.m., motor driven, Allis-Chalmers Mfg. Co.

Turbine-Generators and Auxiliaries

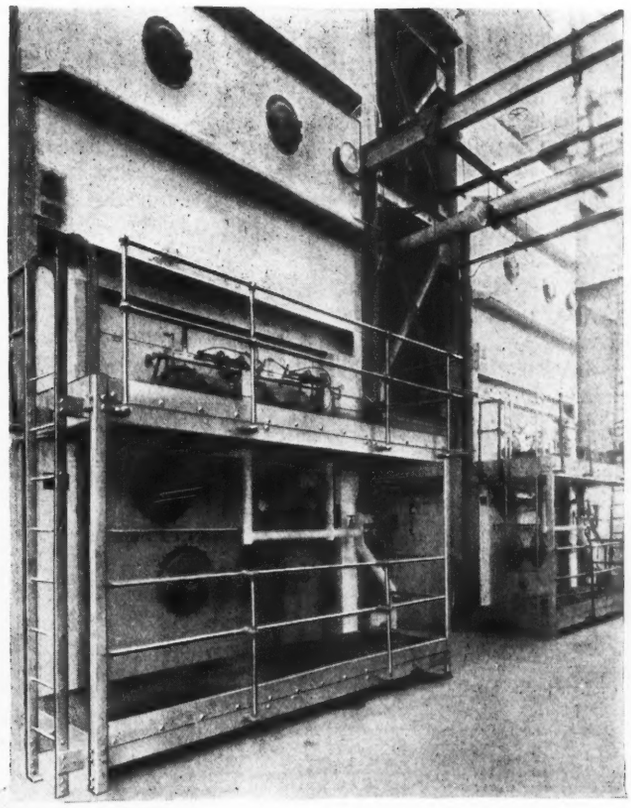
Turbine-generators, two, 3,000 kw., 3,600 r.p.m., 2,300 volts, 60 cycles, 3 phases ..... Allis-Chalmers Mfg. Co.
Generator air coolers, two, 1,670 sq.ft. each, U-fin, Griscom-Russell Co.
Oil purification systems, two ..... S. F. Bowser & Co.
Condensers, two, 2-pass, 3,000 sq.ft. each .. Allis-Chalmers Mfg. Co.
Circulating pumps, two, 690 r.p.m., 4,800 g.p.m.; 30 ft.-head; connected to 1,200-r.p.m., 75-hp. motors, Allis-Chalmers Mfg. Co.
Condensate pumps, two, 1,730 r.p.m., 100 g.p.m.; 100-ft. head; connected to 1,800-r.p.m., 10-hp. motors, Allis-Chalmers Mfg. Co.
Air evactors, two, 2-stage, 2-nozzle, steam-jet air pumps, with aftercoolers ..... Croll-Reynolds Engr. Co.

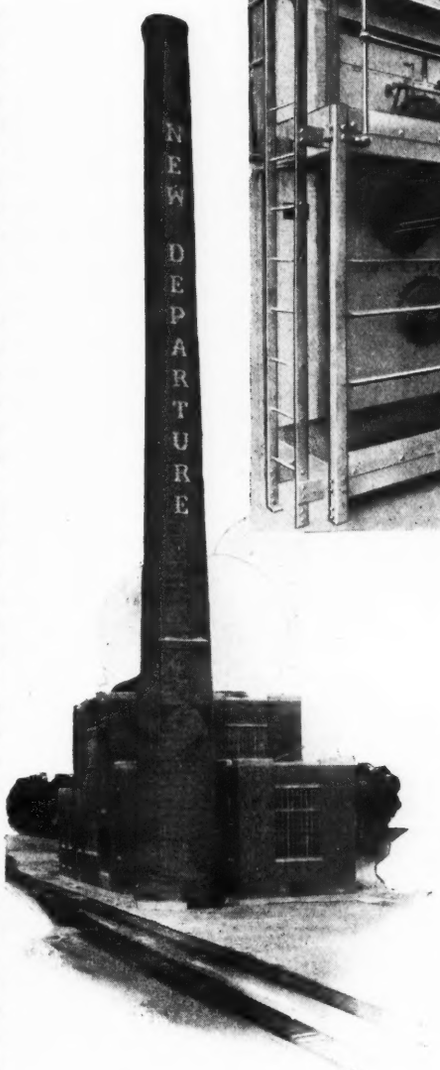
Miscellaneous

Air compressors, two 10/15x18x10 Laidlaw, 2-stage, cross-compound, steam-driven, 402 cu.ft. per min., 125 lb. pressure, Worthington Pump & Mach. Corp.
Crane, one, 15-ton, 39-ft. 2-in. span, hand power ... Whiting Corp.
Fire pumps, two, 18x10x12-in. horizontal duplex reciprocating Underwriters, 1,000 g.p.m. ..... Warren Steam Pump Co.
Fire pumps, two, centrifugal, Underwriters; 1,500 g.p.m., Buffalo Steam Pump Co.
Fabricated pipe ..... Grinnell Co.
Switchboard ..... General Electric Co.
Motors ..... General Electric Co.
Insulation ..... Johns-Manville Corp.

Recent Boiler Practice In New England

By D. D. EAMES
Engineer With Lockwood Greene Engineers, Inc.
Boston, Mass.





Left — Oil- and rubbish-burning plant of the New Departure Manufacturing Company general forge plant. Above—Oil furnace side of two 600-hp. boilers

THE PURPOSE of making this study was to find out how much boiler plant work has been done in New England during the last two or three years and to what extent the modern ideas of boiler and furnace design are being applied. Of particular interest are the types of boilers, the steam pressures, the relative position of pulverizers and stokers, the expected ratings, the use of water-cooled furnaces, and of economizers and air preheaters.

The list of plants analyzed includes a total of fifty, and while no claims for completeness are made, it is believed that this represents a large proportion of the new plants in New England as far south as New Haven and containing boilers of 4,000 sq.ft. or larger, installed in 1928, 1929 and so far (Sept. 1) this year. Some of the later plants are now in process of construction and others are only in the design stage. A few plants with boilers smaller than 4,000 sq.ft. are included in case of some point of special interest. The list includes industrial, public utility, and institutional plants representing an investment of twelve to fifteen million dollars, possibly more.

The analysis is presented in this review in the form of four tables. Table I gives the name of all the plants, the industry which they serve, the number, type and size of boilers, the ratings expected and the steam pressure and temperature. This table is divided into three sections, showing the pulverized coal, fuel oil and stoker plants. Table II gives the superheater data, type and volume of furnace, heat release corresponding to the ratings given in the preceding table, and air preheater and economizer data. Table III gives the pulverized-coal data and Table IV the stoker data.

In most cases the manufacturer's name has been indicated in connection with each piece of equipment, as this adds much to the interest and value of the analysis. Considerable care has been taken to be sure that these statements, as well as the other data in the tables, are correct, and if errors are noted the author would appreciate the correction. Oil is still an important fuel for New England and will undoubtedly remain so for a few more years, although the present indications are that its availability may soon diminish. The new stations named in the table are, of course, a small fraction of the oil-burning plants. Among others might be mentioned the Montaup Electric Company, which at present is using 90 per cent oil and 10 per cent pulverized coal, the Pacific Mills, the American Printing Company and many others. Bunker C oil is selling at present for about $1.05 per

barrel of 42 gal. at point of shipment. This gives a total cost comparing favorably with coal, particularly at points near the main distributing centers of oil. Coal, nevertheless, remains the basic fuel for New England, and most of the new oil-burning plants are designed with the possibility in mind of an eventual change to coal.

Pulverized coal is evidently rapidly forging to the front, showing a total of 22,200 new horsepower capacity against 33,900 for stokers and 15,960 for oil. This showing is more marked because for a number of years pulverized coal did not seem to be making much headway in New England. The list includes plants in the three classifications, industrial, utility and institutional, and most of the plants are designed for high or moderately high ratings. It is worth noting that the two plants having the largest boilers of any in the lists are pulverized-coal units. Perhaps the most notable thing in the pulverized-coal installations is that every plant in the list except one uses unit mills. The one exception employing the storage system was started along this line several years ago, the latest installation being an additional unit.

The stoker plants range all the way from the small plants with stoker of 55 sq.ft. area up to the enormous machine of 539 sq.ft. in the Edgar 1,400-lb. station. Other large stokers are those in the Cambridge Electric Light and the Lynn Gas & Electric Company plants. Stokers and pulverizers have divided the industrial and utility field in the ratio of three stoker plants to two pulverizer plants, there being six utility plants and fifteen indusrtial plants using stokers against four utility and ten industrial using pulverizers.

In the boilers themselves one of the most interesting things is the popularity of the bent-tube type. Forty-six per cent of the installations are bent-tube boilers, which is the more remarkable when the former local prejudice against this construction is recalled. There are on the lists twenty-three plants using bent-tube boilers, seventeen cross-drum, five long-drum, four vertical-tube and one Scotch. The preponderance of the cross-drum over the longitudinal drum is also a comparatively recent development. There is a total of 102 boilers on the lists, the average size being about 7,000 square feet.

Steam pressures show the modern trend toward the higher ranges, although in no extreme degree. There are eleven stations with pressures of 380 to 450 lb., and four of the other stations are designed for ultimate operation at 400 to 450 lb. There are no stations above this range until we get up to the Edgar station, which was a pioneer 1,400-lb. high-pressure plant. The two groups of pressure into which present-day practice is evidently settling are thus finding expression in New England practice.

The situation with regard to steam temperature is much the same as to pressures. There are nine plants with total temperatures from 600 to 750 deg., and three or four others will eventually be increased to these figures.

The practice of operating boilers at ratings in excess of the original 10 sq.ft. per horsepower first found general application about sixteen years ago. The high ratings of those days were 175 per cent, or at most 200 per cent of normal, the limitation being the furnace refractories and the size of the stoker. Development of large stokers and of pulverizers, together with the introduction of cooling elements to protect refractory material, has permitted much further progress. In the tables there are seventeen stations listed which are designed for operation at 300 per cent of rating or higher. Most of these high-rating stations are either utility plants or paper mills, the high load factor of the latter usually justifying the expense of the high-rating design.

The 1,400-lb. boilers at the Edison station gives a good illustration of the inadequacy of the usual terms of "boiler horsepower" and "per cent of rating" to describe the performance of modern boilers. These boilers each have a designed output of 250,000 lb. per hour, the boiler heating surface is 6,973 sq.ft. and the water-wall surface 1,200 sq.ft. The heat added to the steam is 1,185 B.t.u. above a feed temperature of 220 deg. The evaporation from and at 212 deg. is therefore about 305,000 lb., corresponding to a "rating" of 1,275 per cent based on boiler heating surface and 1,090 per cent based on boiler and furnace surface.

The heat release values per cubic foot of furnace average for the pul-

TABLE I—BOILER AND STEAM PRESSURE DATA

		Boilers				Steam	
	Industry	No.	Make and Type	Size	Rating	Pres.	Temp.
Pulverized Coal Plants							
American Thread Co.	Textile	3	Union, bent-tube	657	250	225	497
Arnold Print Works	Textile	2	B. & W., Stirling	403	200	120	350
Brown Co.	Paper	1	W. & W., cross-drum	1,000	400	200	568
Crocker, Burbank Co.	Paper	3	B. & W., cross-drum	489	300	385	620
Fitchburg Paper Co.	Paper	1	Bigelow-Hornsby	1,000	200	250	556
Fitchburg Paper Co.	Paper	1	Connelley	1,160	275	250	556
Hollingsworth & Vose	Paper	2	B. & W., Stirling	500	200	150	466
Oxford Paper Co.	Paper	2	B. & W., Stirling	1,200	450	150	441
Pejepscot Paper Co.	Paper	1	B. & W., Stirling	501	175	175	376
St. Croix Paper Co.	Paper	1	Wickes, 3-drum	740	400	450	725
Boston & Albany R.R.	Round house	2	B. & W., Stirling	445	300	180	380
Boston & Maine R.R.	Round house	2	Heine, V-type	750	250	230	499
Edison Electric Illum. Co.	Dist. heat	2	B. & W., Stirling	1,903	425	225	397
Hartford Electric Lt. Co.	Utility	1	B. & W., Stirling	2,764	550	450	725
Harvard Medical School	Institution	2	B. & W., Stirling	600	400	200	488
Fuel Oil Plants							
Algonquin Printing Co.	Textile	6	Brady Scotch	300	180	200	488
J. & P. Coates Co.	Textile	2	B. & W., Stirling	640	200	200	488
Lorraine Mfg. Co.	Textile	3	W. & W., cross-drum	737	250	225	522
Paragon Worsted	Textile	1	W. & W., cross-drum	716	175	275	489
Plymouth Cordage Co.	Jute	2	Heine, cross-drum	501	200	200	488
Maine Seaboard Paper	Paper	3	B. & W., Stirling	615	325	150	466
Eastern Mfg. Co.	Paper	1	B. & W., Stirling	512	300	150	466
New Departure Mfg. Co.	Ball brgs.	2	B. & W., Stirling	615	200	240	503
Terry Steam Turbine Co.	Turbines	2	W. & W., cross-drum	174	200	400	...
Wm. F. Schrafft & Sons	Chocolates	2	B. & W., cross-drum	519	225	240	463
Washburn Wire Co.	Wire	3	B. & W., Stirling	429	250	400	700
Sears Roebuck Co.	Store	3	Union, long-drum	258	150	175	376
Boston City Hospital	Institution	2	B. & W., long-drum	609	200	150	366
Stoker Plants							
Aspinook Co.	Textile	2	Heine, cross-drum	595	200	225	397
Slatersville Finishing Co.	Textile	2	B. & W., cross-drum	591	200	150	416
United Mer. & Mfg. Co.	Textile	2	B. & W., cross-drum	506	150	200	488
M. J. Whittal Assoc.	Textile	3	Bigelow-Hornsby	506	200	250	506
Bird & Sons	Paper	1	B. & W., Stirling	823	250	225	397
Champion International	Paper	2	W. & W., cross-drum	552	320	145	444
C. H. Deyter & Sons	Paper	2	B. & W., long-drum	457	175	300	522
Great Northern Paper Co.	Paper	2	B. & W., cross-drum	805	200	140	361
Hollingsworth & Vose	Paper	1	B. & W., Stirling	583	300	150	466
Hollingsworth & Whitney	Paper	3	Edge Moor, 3-drum	1,121	450	450	685
New Haven Pulp & Board	Paper	1	Bigelow-Hornsby	760	390	380	615
Penobscot Chem. Fibre	Paper	1	B. & W., cross-drum	631	200	160	371
Boston & Albany R.R.	Heating	3	Heine, long-drum	728	225	240	403
Cambridge Electric Lt. Co.	Utility	2	B. & W., Stirling	1,432	350	420	700
Edison El. Ill. Co., Edgar	Utility	2	B. & W., cross-drum	697	1,200	1,400	750
Lynn Gas & Electric	Utility	2	B. & W., cross-drum	1,582	300	450	700
Malden & Melrose G. & E. Co.	Utility	1	B. & W., cross-drum	537	...	125	353
United Illuminating Co.	Utility	3	B. & W., cross-drum	1,511	200	385	595
New Departure Mfg. Co.	Ball brgs.	1	B. & W., long-drum	600	175	175	376
Osgood Bradley Co.	Car shop	2	Erie City, 3-drum	311	150	150	366
Underwood Elliott Fisher Co.	Typewriters	3	Erie City, Stirling	607	200	125	353
Yale University	Institution	3	Bigelow-Hornsby	500	200	125	353

TABLE II—SUPERHEATER, FURNACE AND HEAT TRAP DATA

	Superheaters		Furnaces			Air Pre-	Econ-
	Type	Deg.	Type	Vol.	Release	Heater	omizer
Pulverized Coal Plants							
Am. Thread	Foster convect.	100	Air sides, water br.	3,945	18,500	.....	.....
Arnold Print	.....	...	Air-cooled walls	2,375	15,100	.....	.....
Brown Co	Foster convect.	180	Fin. tube, 3 sides	7,600	20,000	Combust.	.....
Crocker, Burbank	Foster radiant	175	Foster side walls	3,450	17,200	.....	Foster
Fitchburg Paper	Foster radiant	150	Air-cooled front	7,100	12,200	Lungst.	.....
Fitchburg Paper	Foster rad. & conv.	150	Water arch, air sides	8,000	16,700	.....	Foster
Hollingsworth & Vose	B. & W. convect.	100	Air-cooled walls	2,900	19,200	.....	.....
Oxford	Foster convect.	75	Foster, 3 sides	10,700	21,000	Green	Foster
Pejepscot	.....	...	Air-cooled walls	3,007	12,500	.....	.....
St. Croix	Foster convect.	265	Foster, 3 sides, arch	6,680	18,400	Foster	Foster
B. & A	.....	...	Air-cooled sides	4,000	15,000	.....	.....
B. & M	Elesco convect.	100	Air-cooled walls	5,368	15,600	.....	.....
Edison-Heating	.....	...	Bailey, 4 sides	11,400	29,800	B. & W.	.....
Hartford El. Lt	B. & W. convect.	265	Bailey, 4 sides	19,800	23,000	B. & W.	B. & W.
Harvard	B. & W. convect.	100	Bailey, 4 sides	4,330	24,200	B. & W.	.....
Fuel Oil Plants							
Algonquin	Eles. radiant	100	Scotch (2)	246	93,000	.....	.....
Coates	B. & W. convect.	100	Air-cooled	2,060	27,700	.....	Green e.l.
Lorraine	Foster convect.	125	Air-cooled	3,900	20,000	Lungst.	.....
Paragon	Foster convect.	75	Air-cooled sides	2,790	27,000	.....	.....
Plymouth Cord	Foster convect.	100	Solid walls	2,220	20,200	.....	.....
Maine Seaboard	B. & W. convect.	...	Bailey, 3 sides	3,810	22,000	Plate	.....
Eastern Mfg	B. & W. convect.	100	Bailey bridge wall	2,820	24,800	.....	.....
New Departure	Elesco convect.	100	Solid walls	2,978	18,500	.....	.....
Terry	Foster convect.	...	Solid walls	880	19,600	.....	.....
Schrafft	B. & W. convect.	60	Air-cooled walls	2,190	21,200	.....	.....
Washburn Wire	B. & W. convect.	250	Air-cooled, br. wall	2,660	17,000	.....	On 1 unit
Sears-Roebuck	.....	...	Solid walls	675	25,600	.....	.....
City Hospital	.....	...	Solid walls	2,220	24,100	.....	.....
Stoker Plants							
Aspinook	.....	...	Water-bridge wall	1,750	30,000	.....	.....
Slatersville	B. & W. convect.	50	Water-bridge wall	1,850	28,500	.....	.....
United M. & M	B. & W. convect.	100	Solid walls	1,080	31,300	.....	.....
Whittal	Foster convect.	100	Water-bridge wall	1,625	26,200	.....	Section in boiler
Bird	.....	...	Water-bridge wall	3,855	22,000	.....	.....
Champion Inter	Foster convect.	80	Water-bridge wall	1,600	57,000	Lungst.	Green
Dexter	B. & W. convect.	150	Solid walls	.....	.....	B. & W.	.....
Great Northern	.....	...	Solid walls	1,520	46,600	.....	.....
Hollingsworth & Vose	B. & W. convect.	100	Bailey 3 sides	2,055	36,000	Lungst.	.....
Hollingsw'th & Whit.	Foster convect.	125	F-W 3 sides & arch	3,900	53,500	.....	Foster
New Haven P. & B	Elesco convect.	160	Nygaard bridge				Section
			Bare tube arch	4,800	26,000	Sturte'vt	in boiler
Penobscot	.....	...	Solid walls	1,460	38,700	.....	.....
B. & A. R.R	.....	...	Solid walls	2,450	29,900	.....	.....
Cambridge	B. & W. convect.	250	Bailey 3 sides	6,500	31,000	.....	Foster
Edison-Edgar	B. & W. convect.	160	Bailey 3 sides	10,500	36,000	B. & W.	B. & W.
Lynn Gas	B. & W. interdeck	240	Bailey 3 sides	5,700	35,000	Green	.....
Malden & Melrose	.....	...	Solid walls	.....	.....	.....	.....
United Illum. Co	B. & W. interdeck	150	Solid wall	3,060	43,600	.....	.....
New Departure	.....	...	Solid wall	975	48,000	.....	.....
Osgood Bradley	.....	...	Solid wall	396	52,000	.....	.....
Underwood	.....	...	Solid wall	2,030	26,700	.....	.....
Yale University	.....	...	Solid wall	1,090	40,000	.....	.....

TABLE III—COAL PULVERIZER DATA

	Mills per Boiler.			Burners		Furnace	Ash
	Type	No.	Cap.	No.	Type	Floor	Removal
Am. Thread	Aero	1	6,000	2	Natural draft	Flat, air cooled	Manual
Arnold Print	Atrita	1	2,500	1	Forced draft	Flat, not cooled	Manual
Brown Co	Raymond	2	8,000	2	Forced draft	Hopper, water c.	Manual
Crocker Burbank	Aero	1	6,000	2	Natural draft	Flat, air cooled	Manual
Fitchburg Paper	Atrita	2	5,000	2	Forced draft	Flat, air cooled	Manual
Fitchburg Paper	Atrita	2	5,000	2	Forced draft	Flat, air cooled	Manual
Hollingsworth & Vose	Atrita	1	5,000	1	Forced draft	Flat, air cooled	Manual
Oxford	Aero	2	10,000	4	Forced draft	Hopper, water c.	Sluice
Pejepscot	Lopulco	Bin	System	..	Natural draft	Slag screen	Manual
St. Croix	Aero	2	6,000	2	Forced draft	Flat, air cooled	Manual
B. & A	Aero	1	4,000	1	Natural draft	Flat, air cooled	Manual
B. & M	Atrita	1	5,000	1	Forced draft	Flat, air cooled	Manual
Edison-Heating	Atrita	2	12,500	4	Forced draft	Hopper, water c.	Sluice
Hartford El. Lt	Atrita	4	12,000	8	Forced draft	Hopper, water c.	Sluice
Harvard	Atrita	1½	2,500	1	Forced draft	Hopper, water c.	Steam jet

TABLE IV—STOKER DATA

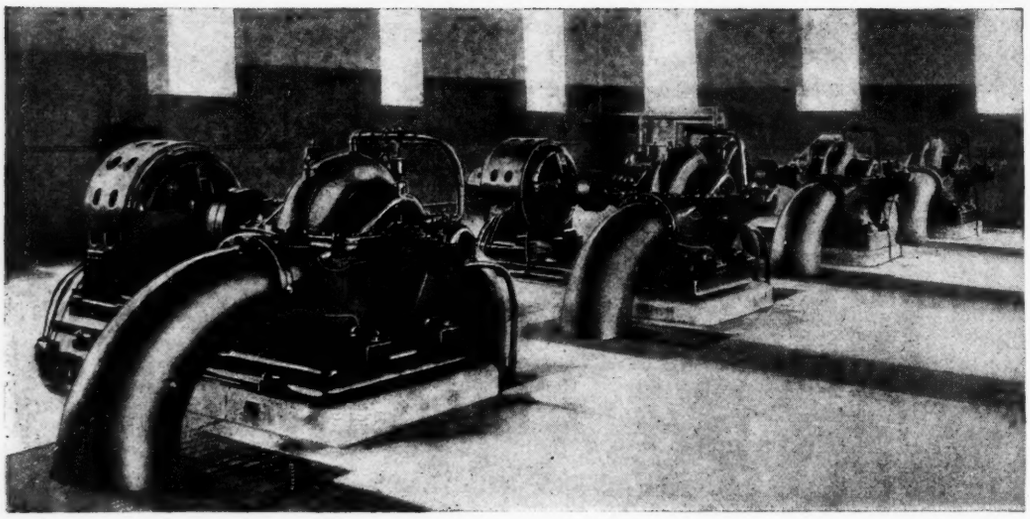
	Stokers					
	Make	Retort	Proj. Area	H.S./ P.A.	Drive	Ash Dump
Aspinook	Riley	5	116	51	Turb. cross conn.	Dump plate
Slatersville	Taylor	5	124	48	4 speed motor	Power dump
United M. & M	Huber	..	91	56	Steam motor	Dump plate
Whittal	Riley	5	103	49	Individual turb.	Dump plate
Bird	Riley	8	206	40	V. S. A.-C. motor	Dump plate
Champion Inter	Taylor	5	123	45	V. S. motor & turbine	Power dump
Dexter	Frederick	4	89	57	V. S. motor	Dump plate
Great Northern	Taylor	7	132	61	V. S. motor	Power dump
Hollingsworth & Vose	Riley	6	113	52	Line shaft	Clinker grinder
Hollingsworth & Whitney	Taylor	10	241	44	Turbine, direct conn.	Clinker grinder
New Haven P. & B	Westinghse.	8	207	37	4-speed motor	Clinker grinder
Penobscot	Taylor	6	138	46	.....	Power dump
B. & A. R.R	Frederick	7	129	57	Turbine	Dump plate
Cambridge	Westinghse.	11	325	44	Turbine	Clinker grinder
Edison-Edgar	Taylor	16	539	13	V. S. A.-C. motor	Clinker grinder
Lynn Gas	Taylor	11	317	50	V. S. motor	Clinker grinder
Malden & Melrose	Coxe	..	121	44	Motor, Reeves drive	.....
United Illum. Co	Taylor	13	266	57	Individual engine	Clinker grinder
New Departure	Taylor	6	97	62	Line shaft	Power dump
Osgood Bradley	Jones	Single	55	54	Steam	Side dump
Underwood	Riley	6	113	54	Individual engine	Dump plate
Yale	Riley	5	86	58	Individual turbine	Dump plate

verized-coal plants 18,500 B.t.u., for the oil plants 27,500 B.t.u., and for the stoker plants 36,100 B.t.u. If the Scotch boiler value is eliminated from the oil plant list, the average becomes 22,000 B.t.u. The figures in the table for heat release correspond to the expected rates of operation as given in the boiler table. They are based on an assumed over-all efficiency of about 82 per cent for plants having economizers or air preheaters, and 75 per cent for plants without. The extreme value in heat release occurs, as might be expected, in the Scotch boiler. The very moderate values for most of the pulverized-coal plants indicates conservative design and a desire to avoid furnace trouble from liquid ash.

All of the pulverized-coal plants have some form of furnace cooling, either air-cooled walls or water walls. In the oil plants there are seven with air- or water-cooled walls and five with solid walls. In the stoker plants the water-cooled bridge wall occurs in eleven cases out of twenty-two, sometimes in connection with more complete cooling and in other cases as the only cooling feature. Several of the stoker plants noted on the list as having solid walls have silicon carbide ventilated block refractories above the stoker line in side walls and bridgewall.

Twenty-two plants, or 44 per cent, use either air preheater or economizer or both. The division in numbers between the two types of equipment is approximately equal. Of the stoker plants six have preheaters and six have economizers. The method of ash removal from the pulverized-coal furnace is of interest. Nine out of fifteen plants have flat bottom furnaces, all but one of which are air cooled. Five of the others have water-cooled hopper-bottom floors.

An interesting feature not shown on the tables is the removal of ash from the stack gases. Some of the stoker plants have installed cinder traps for this purpose. The problem is much more difficult for the pulverized-coal plants. The Harvard Medical School plant, located in a hospital and residential district, is installing a Cottrell static electrical separator. The Edison heating plant, which is located close to the business center of Boston, is installing wet scrubbers.



What Is HEAD? *on a Pump*

Mistakes in calculating the head on pumps have resulted in unsatisfactory installations. This article gives a simple explanation of the different factors that determine the head on a pump and how they are used to obtain the total operating head

By M. F. RENAULT
Philadelphia, Pa.

POWER consumed is a function of pump capacity and the head against which it operates; therefore, estimating pumping head is a matter of major importance. A mistake in estimating the head for a pump may result in obtaining a unit of unsatisfactory characteristics, or, as has happened in some cases, a pump is selected that fails to function.

In a pumping system such as shown in Fig. 1 liquid is moved from a suction well to a point of discharge. Total head against which a pump must operate is made up of several elements. First there is the static head, which comprises the static suction lift and the static discharge head. When both the suction well and discharge are under atmospheric pressure, the static heads are merely differences in elevation. For example, the horizontal center line of the pump is 5 ft. above the surface of the suction well, therefore the static suction lift is 5 ft. On the discharge side of the pump the center line of the discharge stream is 95 ft. above the horizontal center line of the pump. In other words, the static discharge head is 95 ft. and the total static head is $5 + 95 = 100$ ft. To overcome this head the pump has to perform sufficient work to lift the water 100 ft. However, a pump selected on this basis would not deliver its rated capacity, and might fail to discharge water at all.

A pump not only must produce sufficient head to lift the fluid from the suction well to the discharge tank, but it must overcome the friction of the fluid in the piping system.

In Fig. 1 there is 50 ft. of 10-in. pipe and there is an elbow in the suction line. The effects of the elbow in the pipe line can be determined from a handbook table; the loss in head produced by a 10-in. elbow is equivalent to approximately 30 ft. of straight pipe. Therefore the equivalent length of pipe in the suction line is $50 + 30 = 80$ ft. The head losses in pipe can also be determined from handbook tables when the water velocity is known. The velocity of the fluid in the pipe may be obtained by the formula $V = \frac{G.P.M.}{2.45\ D^2}$ where V equals the velocity in feet per second; $G.P.M.$ equals gallons per minute flowing through the pipe; and D equals the diameter of the pipes in inches. Assume a flow of 1,650 gal. per minute in the pipe, then the velocity $V = \frac{1,650}{2.45 \times 10^2} = 6.8$ ft. per second. For that velocity the head loss in feet per 100 ft. of 10-in. pipe is 2.5. In this case the loss in head in the suction pipe is therefore $2.5 \times 80 \div 100 = 2$ ft. Another small loss occurs in the entrance to the suction line, but when a bell mouth is used, as in Fig. 1, this loss is so small that it may be neglected.

In the discharge line there are 597 ft. of 8-in. pipe, a valve and two elbows. The valve produces a loss equivalent to about 35 ft. of straight pipe, and each elbow causes a loss equivalent to about 24 ft. of pipe. Hence, in the discharge line there is the equivalent of $597 + 35 + (2 \times 24) = 680$ ft. of straight pipe. At a velocity of 10.5 ft. per second the equivalent head loss

due to friction in this pipe is 7.7 ft. per 100 ft. of pipe and the total head loss is 680 × 7.7 ÷ 100 = 52.36 ft. This gives a total loss of head in the suction- and discharge-pipe lines due to friction of 2 + 52.36, say 55 feet.

In Fig. 1, when the water leaves the discharge end of the pipe it has a certain velocity that represents a loss. The head necessary to produce this velocity is known as velocity head, or discharge velocity head, and can be calculated by the formula $h = \frac{V^2}{2g}$, where h is velocity head in feet; V velocity of the discharge in feet per second; and g the acceleration of gravity, 32.16. When the discharge from the pipe, Fig. 1, is 1,650 gal. per minute, the velocity $V = \frac{1{,}650}{2.45 \times 8 \times 8} = 10.5$ ft. per second. Substituting this value in the formula for velocity head we have $h = \frac{10.6 \times 10.6}{2 \times 32.16} = 1.75$ ft. It will be seen that where the velocity is kept low and where the static head is high, the velocity discharge head is of minor consequence when calculating the total head on a pump. For low-head pumps and short pipe lines the velocity discharge head may represent a considerable part of the total head on a pump.

The total head on the pump delivering 1,650 gal. per minute is the static head plus the friction head, plus the discharge velocity head, or 100 + 55 + 1.75 = 156.75 ft., say 160 ft. This is known as the total dynamic head.

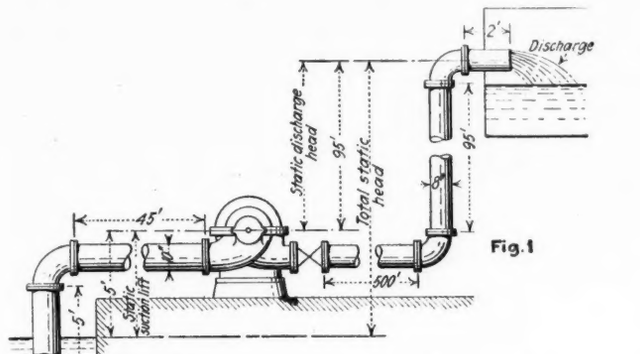


Fig. 1

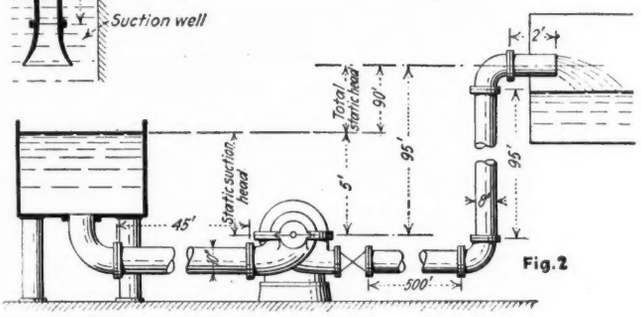


Fig. 2

Fig. 1—Pump with the suction well below it horizontal center line

Fig. 2—Pump with the suction well above its horizontal center line

Instead of a pump lifting the water from a well, as in Fig. 1, its suction may be under static head, as in Fig. 2. Here the surface of the water in the suction well is 5 ft. above the center line of the pump. Therefore the static head on the suction of the pump is 5 ft. This is known as the static suction head. Where the head on the suction is positive, as in Fig. 2, it is subtracted from the discharge static head to obtain the total static head, or, in the figure, the total static head is 95 — 5 = 90 ft.

In Figs. 1 and 2 the surface levels assumed for the suction wells are those that will exist when the pump is running and delivering its full rated capacity. When the suction is a large body of water, such as a lake, the level of the suction well is practically the same when the pump is running as when it is not. In the case of a sump, when the pump is started the water may be several feet higher than when it stops, in which event the pump must be of a design that will lift the water when the suction well level is at its lowest.

It is possible, with a static suction head on the pump, as in Fig. 2, to have a dynamic suction lift. For example, if the static suction head is 5 ft. and the losses in the suction pipe are equivalent to 7-ft. head, the dynamic suction lift is 2 feet.

A pump may operate against a varying static discharge head, such as in the case when the discharge pipe enters the bottom of an elevated tank, as in Fig. 3. If the water level in the tanks is allowed to vary 5 ft. between high and low, the static head will change by that amount. However, when calculating the total head on the pump, the static discharge head is taken as the vertical distance from the center line of the pump to the highest level of the water in the tank. From the foregoing, certain definitions for the head on a pump may be written:

Total static head is the vertical distance from the free surface of the source of supply to the center line of

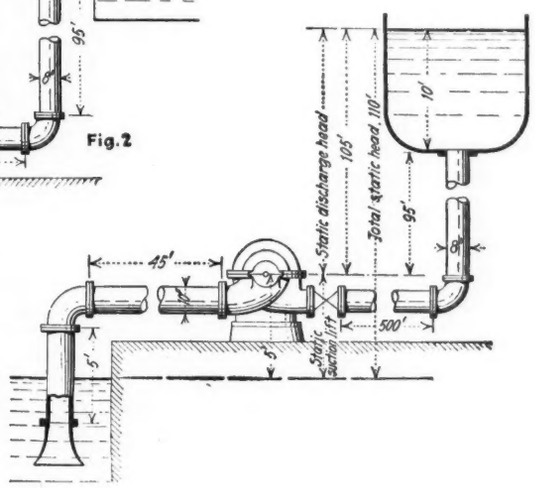


Fig. 3 — Pump has to work against a variable head

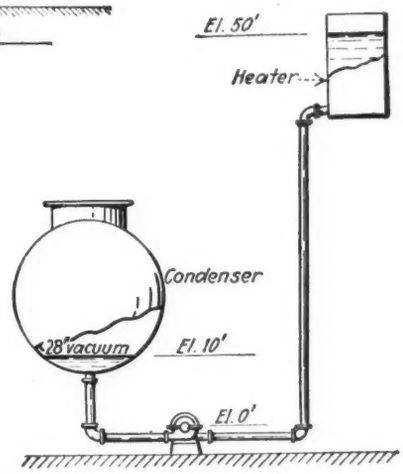


Fig. 4—Condensate pump between condenser and heater

supply to the center line of discharge, Fig. 1, or to the free surface of the fluid, Fig. 3.

Static discharge head is the vertical distance from the horizontal center line of a pump to the horizontal center line of the discharge, Fig. 1, or to the free surface of the fluid, Fig. 3.

Static suction head is the vertical distance from the horizontal center line of a pump to the free surface of the fluid in the source of supply, Fig. 2.

Static suction lift is the vertical distance between the horizontal center line of a pump to the free surface of the fluid in the source of supply, Fig. 1.

Velocity head (when the water is moving at a given velocity) is the equivalent head in feet through which it would have to fall in a vacuum to attain that velocity. Velocity head is sometimes referred to as the head due to velocity, and may be obtained by the formula $h = \frac{V^2}{2g}$, as previously given.

Friction head, at a given velocity of the liquid, is the equivalent head necessary to overcome the friction of a liquid on the surface of the pipe and fittings.

Dynamic suction lift (where static suction lift exists as in Fig. 1) is the vertical distance from the free surface of the source of supply to the center line of the pump plus entrance, velocity and friction losses, but not the pump's internal losses, when the pump is delivering its rated capacity.

Dynamic suction head may exist when the surface of the source of supply is above the center line of the pump, Fig. 2, and is the vertical distance from the free surface of the source of supply to the center line of the pump minus the velocity head and friction and entrance losses, but not minus the pump's internal losses, when the pump is discharging rated capacity. Dynamic suction head exists only when the sum of the velocity head and the head loss due to friction and entrance losses is less than the vertical distance between the center line of the pump and the free surface of the source of supply. If the sum of these losses is greater than the vertical distance from the center line of the pump to the free surface of the source of supply, a dynamic suction lift exists and not a dynamic suction head.

Total dynamic head is the vertical distance from the free surface of the source of supply to the free point of discharge, plus the head due to the friction of the pipe and fittings plus the entrance and exit head losses, when the pump is delivering its rated capacity.

Dynamic discharge head is the total dynamic head minus dynamic suction lift, where a suction lift exists, as in Fig. 1, or plus dynamic suction head, where a dynamic suction head exists, as in Fig. 2. As previously mentioned, it is possible, with the conditions Fig. 2, to have a dynamic suction lift instead of a dynamic suction head on a pump.

Sometimes pumping problems are better understood if absolute quantities are substituted for the conventional ones. In Fig. 4 is shown a condensate pump taking water from a condenser operating at 28 in. vacuum and discharging to a heater subject to atmospheric pressure. The water level in the condenser is at elevation 10, the pump's center is at 0, and the free-water surface elevation in the heater is at elevation 50 ft. The apparent static head is 50 — 10 = 40 ft. However, at sea level, 28 in. vacuum is the same as 2 in. of mercury absolute pressure, or 2 × 1.133 = 2.266, say 2.3 ft. of water absolute pressure. (An absolute pressure of 1 in. of mercury is equal to 1.133 ft. of water.) The atmospheric pressure on the water in the heater is equal to 34 ft. of water. The true static head is therefore (50 + 34) — (10 + 2.3) = 71.7 feet.

Variables that must be considered when dealing with absolute heads are atmospheric pressure and the specific gravity of the liquid handled. Assume the system, Fig. 4, is used to handle 1.1 specific gravity brine from a chamber at 20 in. vacuum, located 5,000 ft. above sea level. The barometer at 5,000 ft. altitude averages 24.5 in. of mercury; therefore a vacuum of 20 in. corresponds to a 4.5-in. abs. pressure. An inch of mercury is the equivalent of 1.03 ft. of 1.1 specific gravity brine. The atmospheric pressure on the liquid in the heater is equal to 24.5 × 1.03 = 25.235 ft. of brine, and the pressure on the liquid in the condenser is 4.5 × 1.03 = 4.635 ft. of brine. Therefore the total static head is (50 + 25.235) — (10 + 4.635) = 60.715 ft. of brine. It should be noted that the absolute head to be added to the discharge elevation is the barometer in feet of brine.

When the total dynamic head has been determined, the horsepower to drive the pump can be calculated by the formula:

$$Hp. = \frac{G.P.M. \times H \times S}{3{,}960 \times E}$$

Where *G.P.M.* is the pump capacity in gallons per minute; *H* the total dynamic head in feet; *S* the specific gravity of the fluid pumped; 3,960 is obtained by dividing 33,000 ft.-lb. per minute, the equivalent of one horsepower, by 7.481, the pounds weight of 1 gal. of water; and *E* is the over-all pump efficiency expressed in hundredths. For water the specific gravity is 1 and may be neglected in the formula for horsepower. Thus, if the capacity of the pump in Fig. 1 is 1,650 gal. per minute, the total dynamic head is 160 ft., and the pump efficiency for this condition is 0.75, the horsepower required to drive it is:

$$Hp. = \frac{1{,}650 \times 160}{3{,}960 \times 0.75} = 88.88,$$

in which case a 100-hp. motor or other type of motive power should be selected.

One Hundred Hook-Ups

More than thirty full-page blue prints ✦ More than one hundred hook-ups — fundamental sequences of major power units ✦ More than one hundred different units ✦ All told, more than a thousand "appearances" of these units

The Nov. 25 number of *Power* will be unprecedented in form, in contents and in permanent usefulness. Further explanation next week

Vacuum-Tube Rectifiers Control Motor Speed

Operation of a Thyratron, a mercury-arc rectifier with grid control, and its application to control the speed of direct-current motors supplied by alternating-current circuits

By W. R. KING
Industrial Engineering Dept.
General Electric Company

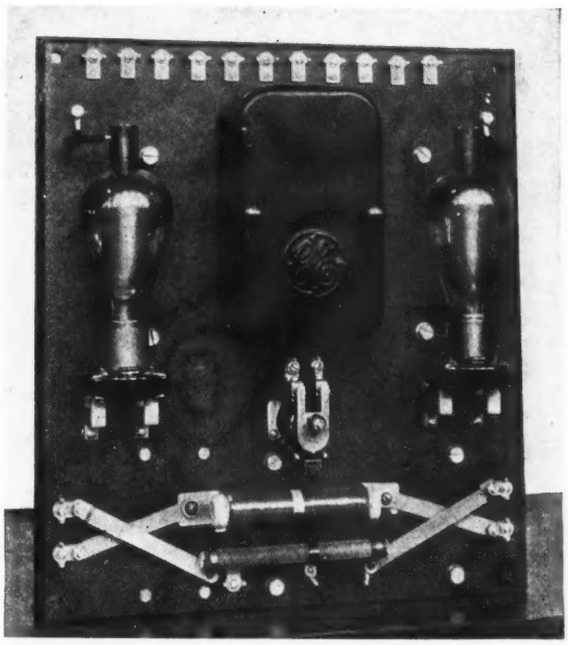


FIG. 1—THYRATRON PANEL FOR CONTROLLING SPEED OF 1-HP. 230-VOLT MOTORS BY ARMATURE CONTROL

The two Thyratron tubes are shown at the sides of the panel. On the front of the panel are also mounted the anode contactor, field-protective relay and resistors. The power transformer, direct-current smoothing reactor and grid transformer are mounted on the back of the panel

PRACTICALLY speaking, the Thyratron is a mercury-arc or mercury-vapor rectifier incorporating a control electrode or grid. When the grid is energized by a voltage properly related to the power applied to the tube it is possible to control the average value of the rectified output. As used in direct-current motor-control equipment the Thyratrons are so connected as to form a full-wave grid-controlled rectifier. This arrangement may be used to supply direct-current motor-armature power, thus providing motor speed control by armature voltage variation somewhat after the manner of a non-reversing, non-overhauling Ward-Leonard system. It may also be used to supply motor-field excitation to adjustable-speed direct-current motors.

The single-phase, full-wave, grid-controlled rectifier is perhaps the simplest form of this equipment. Fig. 2 shows the wiring diagram of such an arrangement. Consider the operation of Thyratrons as plain rectifiers, and for simplicity assume a resistance load. When point *A* is positive, tube No. 1 passes current in the direction indicated by the arrows, that is, from anode to cathode, through the load and back to the center tap of the transformer secondary. This flow continues throughout the duration of the half cycle, when point *A* is positive. During this same half cycle point *B* is negative, and therefore no current flows through tube No. 2. The voltage across the load is represented by wave 1 in Fig. 3. At the beginning of the succeeding half cycle point *A* becomes negative, the current through tube No. 1 stops, point *B* becomes positive, and current flows through tube No. 2 as indicated by the arrows. This current flows through the load in the same direction as the current of the previous half cycle. At the end of the second half cycle, point *A* again becomes positive, the current passes through tube No. 1, and the operation repeats itself, giving a uni-directional pulsating voltage, Fig. 3.

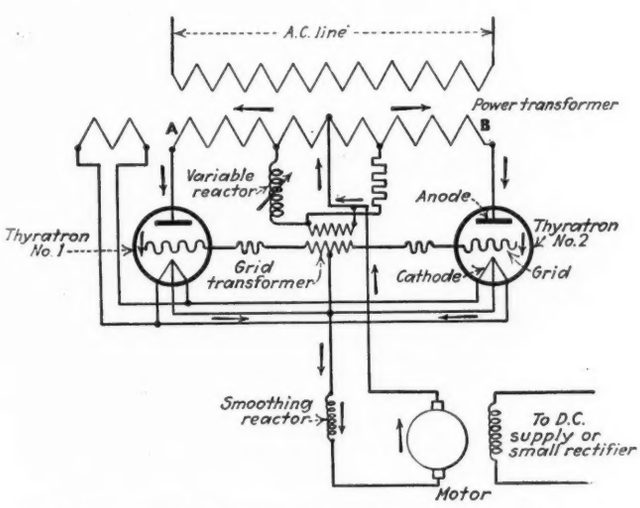


Fig. 2—Diagram of a single-phase full-wave grid-controlled Thyratron rectifier

When applying this pulsating voltage to the armature of a motor the ripple must be limited to secure good commutation. This is accomplished by connecting a suitable smoothing reactor in the direct-current circuit.

Fig. 4 illustrates the principle of grid control. For a given plate voltage there is a particular grid voltage at which ionization will just occur, thus allowing the tube to pass current. If the grid potential is below this critical potential no discharge will occur and no current will pass. As soon as the grid potential is increased above the critical voltage, ionization occurs and the tube passes current, providing the anode is positive with respect to the cathode. Once the anode current is started, the grid has no appreciable effect on it. The grid cannot stop the flow of current, but can regain control to keep it from

starting again if the flow ceases long enough for the mercury vapor to deionize.

If an alternating-current voltage is applied to the plate, the grid has an opportunity of regaining control once each cycle, and can delay the start of the arc for as long a period during the cycle as the grid is sufficiently negative. Therefore if the grid as well as the plate is supplied with an alternating current the phase relation between the grid and plate voltage determines the point in the wave at which current begins to pass, hence the average amount of current passing through the tube. Fig. 4 shows this relationship for one anode; the dark portion indicates current. In a full-wave system, the anode and grid of the other tube operate similarly during alternate half cycles.

There are several methods of obtaining the shift in phase between the grid and plate voltages. Fig. 5 illustrates a typical system in which an alternating-current voltage in phase with the anode voltage is applied to a

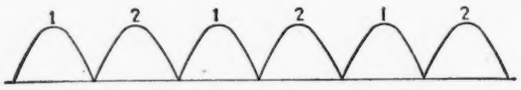


Fig. 3—Curves represent a pulsating current

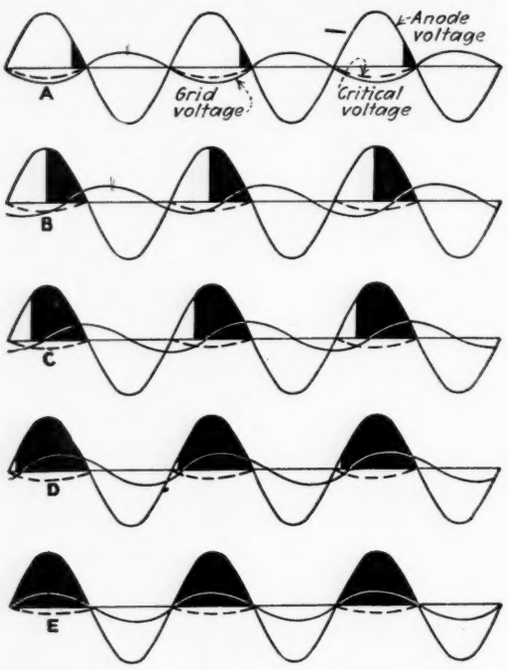


Fig 4—The principle of grid control of the direct current to a motor. The dark portions of the curves indicate current flow

transformer whose secondary is loaded with a resistance R and a variable reactance X in series. Voltage E_g is applied to the grids. As X is varied E_g rotates with respect to E, providing the desired phase shift in the grid voltage.

A typical method of applying this system is to use a solenoid coil for the variable reactor. The reactance of the magnetic circuit is changed by moving the soleniod armature. This changes the reactance of the coil, which in turn, shifts the phase of the grid voltage; consequently, the direct-current output voltage is varied. In a typical case, a movement of $1\frac{1}{2}$ in. of a 2-oz. armature is sufficient to change the Thyratron output voltage from zero to maximum. A small rotary regulator, similar to a Selsyn motor, may also be used to shift the phase of the grid voltage.

As stated previously, the rectifier equipment may supply either motor armature power or motor excitation. Of course, a much greater speed range is secured by using armature voltage variation. At present Thyratron control can be considered for motors up to 5 hp., 230 volts, using armature voltage control. Thyratron equipment for motors up to this size may be built to operate on single-phase alternating current at any commercial low voltage and frequency. An installation of this nature requires either a direct-current source of supply in addition to the alternating current or the installation of a small rectifier for motor excitation. A rectifier can be provided as part of the tube panel or separately, as desired.

The speed range which may be obtained with Thyratron excitation equipment is limited by the motor itself. The equipment in this case merely provides a direct-current source of excitation with unusual control features, and may be built to operate from single-phase alternating-current at any commercial low voltage and frequency. Since it is possible to obtain equipment that will deliver up to 5 kw. at 230 volts, motors of considerable size can be controlled in this manner, provided both alternating and direct current are available. The occasion that would warrant the installation of a motor-generator or rectifier to supply armature power, in addition to the Thyratron equipment to supply controlled excitation, would be unusual, although instances justifying such an arrangement may arise.

A Thyratron panel capable of controlling motors up to 1 hp. at 230 volts by armature voltage variation or by supplying excitation up to 1 kw. at 230 volts is shown in Fig. 1. This panel shows the two Thyratrons, the anode circuit contactor, field protective relay and resistors. The power transformer, direct-current smoothing reactor, and grid transformer are mounted on the back of the panel. A panel similar to that in Fig. 1, but employing two of the larger Thyratrons, will supply armature power to motors up to 5 hp. at 230 volts, or 250-volt excitation up to 5 kilowatts.

Hot cathode Thyratrons require a brief time for heating of the cathode before power is applied. This is necessary to prevent damage to the cathode, which might result in tube failure or a considerable decrease in tube life. Five minutes must be allowed for the large Thyratron; for the small tube one minute is sufficient. Thyratron control panels may be supplied with automatic timing devices to prevent the application of power before the

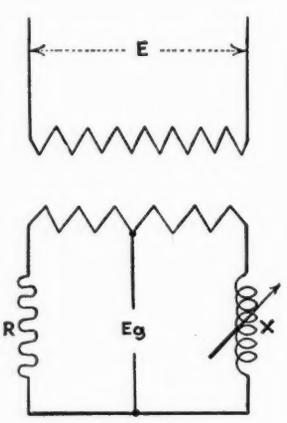


Fig. 5—Diagram of phase-shifting method of grid-voltage control, consisting of a transformer whose secondary is loaded with a resistance *R* and a variable reactance *X* in series. Voltage *Eg* is applied to the grids. As reactance *X* is varied, voltage *Eg* rotates with respect to *E*, providing the desired phase shift

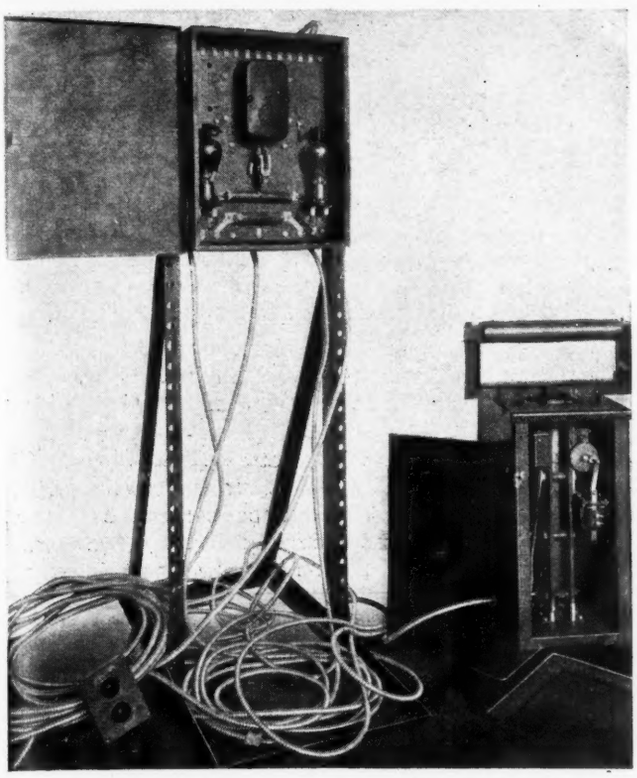


Fig. 6—Thyratron control panel in the upper left with controlling element in the lower right

cathode is hot. Where frequent starting and stopping of motors occurs the cathodes are allowed to remain heated during stops and the time delay occurs only on the early morning starts. The Thyratrons are rated on an average current basis. Two of the smaller Thyratrons in a full-wave rectifier will supply 5 amp. average. On a similar basis, two of the larger Thyratrons will supply up to 25 amp. average.

Life of the tubes depends on the service in which they are placed. Typical estimates run from 2,000 to 10,000 hr. Expected life can be estimated on specific applications.

Possible Applications

Potential applications of this system are many. An installation in Schenectady is maintaining constant tension on a wire-drawing winder. In this case, a solenoid armature is attached to a floating pulley and moves up or down as the tension of the wire under the pulley increases or decreases. The winder motor speed is decreased or increased accordingly. The operation being continuous, and the response to a change in tension almost instantaneous, a practically constant tension is the result.

A similar equipment is being installed on the reel of one of the large cable-sheathing machines. Fig. 6 shows the Thyratron equipment, with the controlling element, for this application. A man had previously been employed to control the reel speed as the loop in the large cable was varied by increasing reel diameter or by speed variation in the sheathing machine.

It is felt that this system offers distinct advantages in solving some of the more difficult small motor control problems. Because of the very small actuating force required, and the precise response to delicate functions, many additional possibilities are open to consideration, from both an economic and engineering angle.

New Full-View Stroboscope For Continuous Vision

THE PRINCIPLE of the stroboscope is very old. For years this scientific device has been used in various forms to study the motion of machine parts rotating or moving over any definite path with a fixed period. One form of stroboscope uses a slotted disk rotated at such speed that the slot crosses the line vision each time the object reaches a certain point in its cycle. Thus the point viewed appears to be at rest except for variations of position from one cycle to the next. This form of stroboscope generally permits only one small area at a time to be investigated.

A later form of stroboscope uses an intermittent neon lamp, timed to the cycle to illuminate the whole object with a brief flash each time it reaches a certain position.

Both of these forms of stroboscope have distinct limitations when used to investigate the motion of the latch on such a device as a turbine emergency trip. Here a truly continuous rather than intermittent view of the entire object is desired so that the motion of the latch may be observed from the moment of release.

Such a study may be made with the prism type of stroboscope, described in the October number of the *General Electric Review*. Its operation depends on the principle that a prism properly shaped, held and rotated will produce an image that rotates twice as fast as the prism and in the same direction.

The following description of the operation of this stroboscope is quoted from the source mentioned.

"In order, then, to watch the action of such a device [the emergency trip] a relatively large erecting prism was mounted inside the inner race of a large ball bearing in such a way that the center of the field of vision in the erecting portion was concentric with the axis of rotation of the prism.

"If we now study what goes on in the erecting field of this prism we shall see that if we are looking at some printed matter through the prism, and then rotate it slowly, the printing travels around at a rate twice as fast as we rotate the prism; and the rotation of the printing is in the same direction as the rotation of the prism.

"If we now revolve the printed matter at exactly twice the rate at which we rotate the prism, we shall find that the printing remains at rest. We therefore arrange to drive the prism that is mounted inside of a ball bearing, at a rate of exactly one-half the rate of rotation of the emergency disk, and in this way we bring the mechanism visually to rest, and have the privilege of watching it all the time, no matter what the speed of the disk may be.

"There are other types of devices, such as the centrifugal starting switches for motors, and the like, which should be designed correctly with the same snap-action characteristics. Unless the design has been carefully worked out, it is quite possible that the mechanism does not snap out but hesitates or vibrates a little; and if this vibration is persistent means are available for analyzing the frequency of vibration. In this case the switch disk may be brought to rest visually by means of the rotating prism, and the frequency of vibration determined by a stroboscope disk driven at various known speeds by a variable-speed motor. In this way complete action of the mechanism may be readily determined and the design changed to eliminate the undesirable features."

New Compressor Delivers Gas at 14,000 Lb. Pressure

THE TREMENDOUS PROGRESS the nitrogen industry has witnessed during the last few years has led to the development of special compressors, some of which work at a final pressure of about 1,000 atmospheres.

The development of these machines dates back to the pioneer work of Georges Claude, who was the first to recommend the use of very high pressures for ammonia synthesis. With noteworthy energy, at a time when makers of machinery still fought shy of the subject, he strongly urged the mastery of such super-pressures. Until a few years ago the appliances available for working at these pressures were only large enough for laboratory purposes. But in the course of time leading engineering works have developed hyper-compressors up to the largest capacities without any difficulty whatever.

The firm of Sulzer Brothers, Winterthur, Switzerland, introduced a type which differs radically from those hitherto known and which has a number of important advantages from operating and technical angles.

The starting point of this development was the well-known Sulzer gas compressor for pressures up to 300 atmospheres. These machines are constructed with as many as six compression stages and, from a theoretical point of view, it would be sufficient to add a further stage to the 300-atmosphere machines to obtain a presure of 1,000 atmospheres. The dimensions of the extra cylinder would not be unduly large, by any means, as the gas at 300 atmospheres already has a very small specific volume. The extra power necessary would also be moderate, the increase being in proportion to the logarithm of the pressures.

In actual practice, however, there is a great difference between working at a pressure of 300 atmospheres and at 1,000 atmospheres, since the gas at the higher pressure is so dense and heavy, and so changed in its chemical characteristics as regards attacking the material of which the compressors are made, that it was necessary to consider special methods of construction to cope with the altered circumstances.

The fundamental characteristic of the Sulzer hyper-compressor is the vertical arrangement of the cylinders for the sixth and seventh stages; these cylinders are operated hydraulically by columns of oil and are known as hyperstages in the data supplied by Sulzer Brothers. Embodied in this arrangement is the idea of regarding the hyper-stages as more or less separate machines, both constructively and also from a practical working point of view.

The design of the cylinders may be seen by referring to Figs. 1 to 3, which show the machine recently supplied to the Compagnie de Bethune S.A., Bully-les-Mines. The compressor is designed to deal with an effective suction intake of 4,000 to 4,500 cubic meters per hour (141,240 to 158,895 cu.ft.) at a final pressure of 1,000 to 1,100 atmospheres (14,700 to 15,170 lb. per square inch). It is driven by a three-phase motor of the flywheel type, mounted on the shaft, the motor delivering a constant output of approximately 2,000 hp. at the normal speed of 122 r.p.m. Two such units have been laid down for the time being, but it is intended to lay down a number of similar compressors for extensions. The machine has a two-throw crankshaft, the first, second and third stages (Fig. 1) being operated by one crank, and the fourth and fifth (Fig. 2), together with the primary oil cylinder (Fig. 3), by the other. All the horizontal cylinders are fitted with detachable and interchangeable cast-iron liners

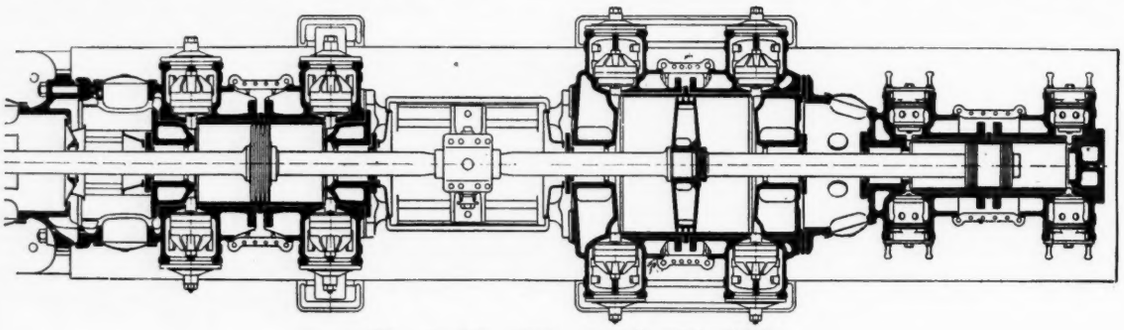


Fig. 1—The first, second and third stages of the Sulzer Brothers compressor

having the well-known Sulzer type of flange in the middle, so that expansion may take place freely toward both ends of the cylinder.

The cooling-water jackets are made in two parts, making the water chambers readily accessible at all times for cleaning and obviating, so far as possible, any indeterminate stresses in the cylinder walls, as would otherwise be the case with integral cooling jackets. The first and second stages, which are those having the largest bores, have disk pistons that float on the piston rods. The piston rod is made in two parts for each side of the machine, with a knuckle-joint connection in the slipper between. Metallic packing of the Kranz type is used for all horizontal glands, and the glands themselves are arranged to be adjustable from the outside. Spring-loaded ring valves are used up to and including the fifth stage, their construction being of the ordinary type; their chief characteristic is small weight, which enables them to operate silently and dependably even at a comparatively high rate of speed. The valve seatings may, if necesary, be divided up into a number of interconnected rings that provide an opening of large cross-section with small lift, thereby offering a perfect indicator diagram even at the rotative speed chosen.

The chief item of interest in this machine, however, is

the two hyper-stages. They are shown in section and elevation in Fig. 3. The primary oil cylinder is fitted between the frame and the cylinder for the fourth stage on the high pressure side of the machine, while the secondary oil cylinders stand at both sides of the primary oil cylinder, with the gas cylinders of the sixth and sevenh stages arranged vertically on top. The arrangement is kept as compact as possible, to obtain a short column of oil.

An oil pipe of ample size runs from both sides of the primary oil piston to below each of the secondary pistons in such a way that the motion of the primary system is transmitted direct to the secondary pistons by means of hydraulic columns. Unavoidable loss of oil through leakage, blowing off of valves, or the limitation of the stroke, as mentioned below, would shorten the column and thereby tend to make transmission of movement inexact; such loss is compensated automatically by the supplementary feeder pump after each stroke. Each side of the transmission column is rendered safe from excessive stress by the provision of safety valves. Should a plunger stick, no damage would be done to the machine (which would inevitably be the case with a purely mechanical means of operation), as the appropriate safety valve would open and the oil pressure column would collapse. In other words, after the plunger concerned has stopped working the machine can run on safely for some time, that is, until the attendant has been able to stop it. The plungers are connected by flanged couplings to the piston rods of the secondary oil pistons, while the gas cylinders themselves are placed in the frame from above.

The hyper-cylinders are made of a specially tough Siemens-Martin steel, and are of the typical mushroom form, as will be recognized from the section drawing. This form corresponds, approximately, to a body of uniform strength. The mushroom head contains the valves, and the great thickness of the walls is necessary owing to the weakening of the material by the radial arrangement of the valve borings. A cooling jacket is not considered necessary, but it can easily be fitted if required by special circumstances. On the other hand, the plungers are intensively cooled by water conducted through a central boring and run in and out by pipes in the usual way. Cooling is augmented by an ample circulation of oil in the front gland, which is constructed in such a way that the plunger moves in a continuous bath of cold oil.

The main characteristic of the valves for the highest pressures is the valve head without a guide. Any one who has had an opportunity of inspecting a valve which has just been taken down will at once recognize the advantages of the type of valve without a guide. With the Sulzer valve, the head hangs on the spring, and so long as the spring is free to move even an incrusted valve will act properly. The place of contact on the valve seating alters with each stroke, as the valve head operates with a dancing movement. As a result, on the one hand, mechanical impurities are automatically removed from the seating surfaces, and, on the other hand, the valve seating does not wear the valve head, which means that the valve is preserved much better. The stroke of the valve can be adjusted as required by suitable formation of the valve stop, which at the same time serves as a spring guide.

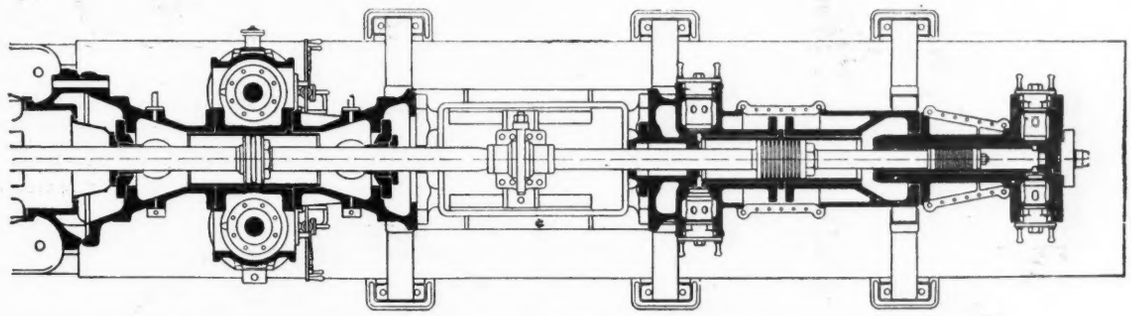


Fig. 2—The fourth and fifth stages are double-acting and the sixth is single-acting

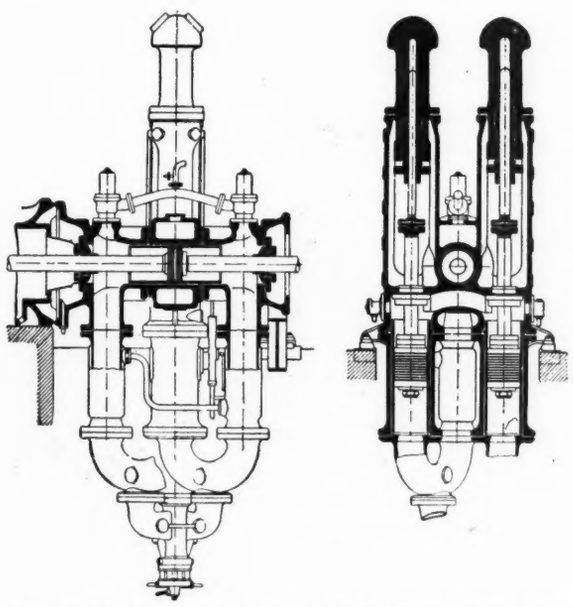


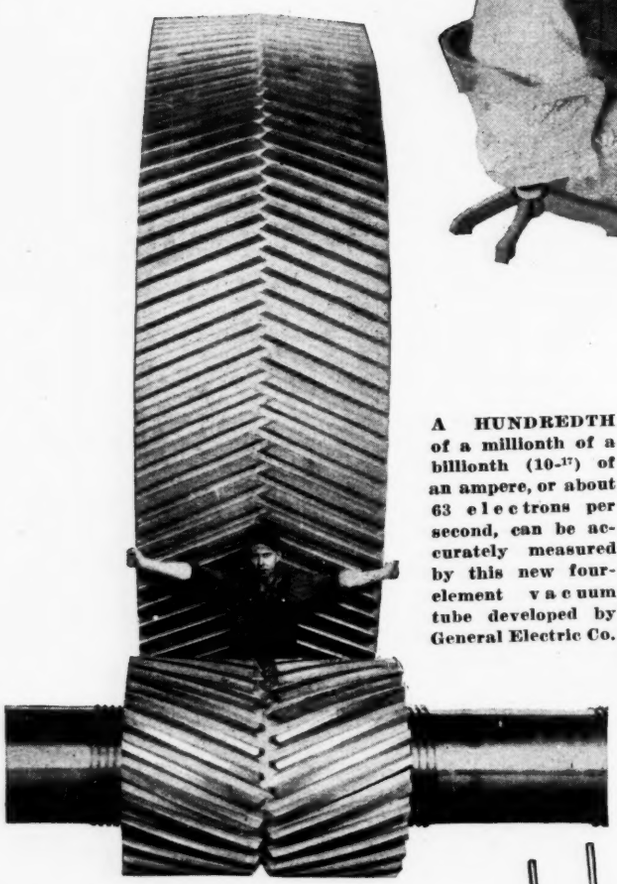
Fig. 3—Sections through the oil-actuated seventh stage

A further characteristic of the Sulzer hyper-compressor is the limitation of stroke of the plungers for the sixth and seventh stages; this permits of the stroke of the plunger being adjusted, which is technically equivalent to regulation by altering the clearance. If the limitation of stroke is shifted downward the plunger at the top of its stroke is lower, and the cylinder affected thereby operates with an increased clearance. The reverse holds good in the case where adjustment is set for a greater stroke. By this means the utmost consideration can be extended to new conditions by altering the output.

For altering the stroke, the secondary oil cylinder has a number of oil outlet channels which are opened or closed by the secondary piston. These channels discharge into an oil reservoir through a slide valve that can be adjusted by hand. The number of channels opened depends upon the setting of this valve, and the piston, in its movement upward, comes to a stop as soon as the first open channel is reached.

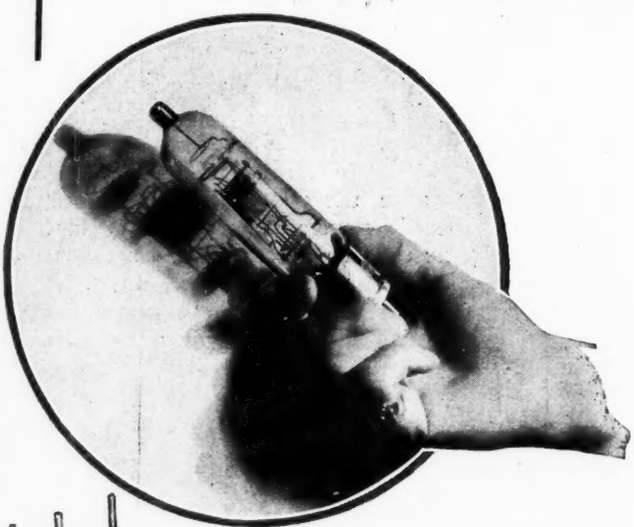
Camera Contrasts Engineering Innovations

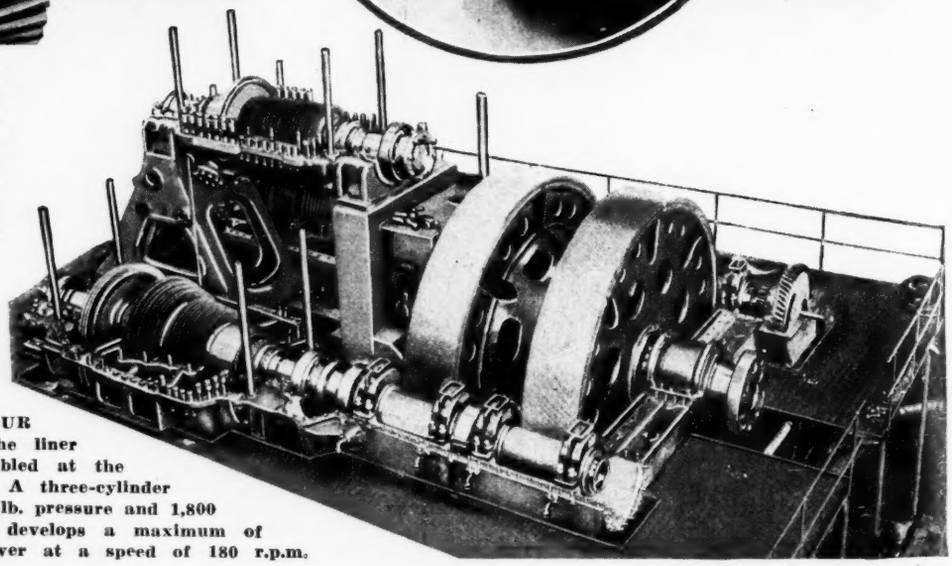
ON THE JOB in an armchair: this is believed to be the first installation of its kind in the world where the operator sits in comparative ease instead of having to walk back and forth to make observations and vary controls. It was developed by Westinghouse for control of electric furnaces in a Niagara Falls plant



GEAR AND PINION of an enormous totally enclosed single-reduction Falk gear unit recently purchased to drive an aluminum mill in connection with two 3,000-hp. motors. The pinion and gear have 27 and 139 teeth, 2 D.P., 48-in. face. The gear was cast in one piece and required 81 tons of steel

A HUNDREDTH of a millionth of a billionth (10^{-17}) of an ampere, or about 63 electrons per second, can be accurately measured by this new four-element vacuum tube developed by General Electric Co.





ONE OF THE FOUR steam turbines of the liner Bremen being assembled at the works in Germany. A three-cylinder unit operating at 327-lb. pressure and 1,800 r.p.m., each turbine develops a maximum of 30,000 shaft horsepower at a speed of 180 r.p.m.

. . . RIGHT OUT OF THE PLANT . . .

Loss of Steam Through Small Drain Lines

WE ARE OPERATING a sawmill where steam power produced from waste fuel is abundant. However, an addition of byproduct machinery has loaded our three boilers considerably. Under the sawmill proper there are seven drains from large steam mains supplying a steam-driven air compressor and other steam-driven apparatus in the mill. The drains are all connected to a large pipe extending 70 ft. or more from the mill.

It was decided to install a sand dryer, and one of the small steam-line drains was disconnected and carried to the dryer. On disconnecting this particular drain from the main line it was found that the supposedly tight valve leaked badly. Further investigation, by disconnecting the various drains, showed even worse leaks. It is safe to say that sufficient steam to produce 50 to 60 hp. was being lost through the drains.

Connecting of drains and small exhaust lines to a central drain may be good practice, but a check-up should be made from time to time to see if any steam is being wasted.

W. S. WHITING, JR.

Butler, Tenn.

Advantages of Thin Fires and High-Induced Draft

IN THE article by Bert Houghton in the Sept. 30 number, relative to stoker operation with high and low furnace drafts, it is not a question of overfire draft as against balanced draft, which the text seems to indicate, but the old story of thick or thin fires.

Mr. Houghton left out one important factor, the type of coal burned. The coal that he is probably using, a low-volatile bituminous having high heat value, strong coking qualities, comparatively slow ignition and ash of high fusion temperature (2,600 deg.) with little pyrites, would have to be burned with a different fuel bed than coals in other localities. Therefore, even though he has evidently had better success with his multiple-retort stokers by using the methods he advocates, he is going a little too far in claiming that the use of heavy fuel bed and low overfire draft is an incorrect method of operation.

Let us analyze the conditions of operation. To burn a certain quantity of fuel requires a definite weight of air, and the amount of fuel that can be burned in a given time, upon which the boiler output depends, is limited by the area of the grate and the physical characteristics of the grate, neglecting such other limiting factors as the furnace volume, B.t.u. release, radiant-heat absorption, draft capacity and mass flow through the gas passages.

Physical limitations of the grate itself depend upon the feeding mechanism, the tuyère opening and the ash discharge ability. And in these respects no two makes or types of stokers are alike. The air pressure drop between the stoker plenum chamber and the furnace depends upon the thickness of the fuel bed and the resistance of the grate. The total drop in pressure to overcome this resistance is the algebraic sum of the pressures, that is, the plenum chamber and the furnace, so that the 0.70 in. increase in furnace draft shown in the article must be added to the plenum chamber pressure to get the total pressure required to force the necessary amount of air through the coal. Under the thin fire condition it is 1.23 in., against 1.69 in. for the heavy fire condition. Had the plenum chamber pressure been increased to 1.20 in. and the overfire draft decreased to 0.03 in., the same amount of air would have been delivered through the fuel bed as with the 0.50-in. plenum chamber pressure and the 0.73-in. overfire draft.

Similarly, under thick fire conditions increasing the draft to 0.73 in. would have necessitated reducing the plenum chamber draft from 1.66 to 0.96 in. to admit the same quantity of air. A high furnace draft, theoretically, is no disadvantage, but with the average boiler setting it is a practical disadvantage, as the excess air infiltration does not mix with the furnace gases but penetrates only a few inches into the furnace. Another drawback is in the increased power required by the induced-draft fans, as the lack of pressure from the forced-draft fans must be supplied by the induced-draft fan.

Returning to the question of thin or thick fires, I have found that the Eastern coals, due to their coking qualities and type of clinker, require thinner fires for the same rates of combustion per square foot of grate area than do Mid-Western coals or the true high-volatile bituminous coals. If the rates of combustion are low, for a given boiler output, thinner fires can be maintained than if the boiler is understokered, and high rates of combustion ensue. The danger of thin fires is that they are more sensitive to careless operation, as a slight change in the air pressure will make a larger change in the air supplied, and therefore the combustion efficiency, than with thick fires. Also, the heat reserve, or ability to absorb changes in boiler output requirements from thick fires, is a practical operating advantage. As an example, under hand control, with natural-draft and induced-draft chain-grate stokers burning Pittsburgh No. 8 coal, changing the method of operation from high chain speeds and thin fires to slow speeds and heavy fires measurably

increased the load capacity of the boiler plant, and also the boiler efficiency. This was the practical result, even though I admit that with more careful operation, there should not have been the large difference in the resulting advantages of the heavier fires.

In regard to high or low furnace draft, Mr. Houghton's statements regarding the velocity of air through the fuel bed under both conditions is not quite correct. With a given stoker, or number of tuyères, the average velocity of the air is independent of the relative apportionment of drafts. Thus there would be no difference in the average air velocity between a plenum chamber pressure of 0.50 in. with a furnace draft of 0.73 in. and a pressure of 1.20 in. with an 0.03-in. furnace draft, as the total pressure head would be the same for either condition, provided the fuel beds were the same. However, there is no question that with an uneven fuel bed there would be areas of high and low velocities, but this would occur with both methods of operation. Similarly, if the thick fire condition, due to the nature of the fuel, caused coke balls, so that the fuel bed was loose and dense in spots, the same trouble would be found, whether the plenum chamber pressure were 1.66 in. with 0.03 in. furnace draft or 0.96 in. with 0.73 in. furnace draft. So long as the resulting pressure difference between the plenum chamber and the furnace is constant there is no difference, in the burning of the fuel, how this pressure drop is made. Nor can the vacuum make a difference in the porosity of the fuel particle, as this is purely a function of the physical characteristic of the coal.

Though I have experienced the failure of ignition at high ratings, and this even with coals less hard to ignite than the semi-bituminous coals, I have never attributed it to anything other than operating the stoker beyond the capacity limits for the furnace temperature; in fact, I have regained ignition of the fuel by decreasing the furnace draft so that there was a positive pressure, instead of draft, in the furnace. This method of operation is required when burning an extremely hard-igniting fuel, like coke breeze, where a slight plus pressure is always maintained at the gate under the ignition arch.

There is no question that a high furnace draft is conducive to lower refractory maintenance, due entirely to cooling of the face of the brick by infiltration of air, and probably a reduction in stoker maintenance by a combination of lowered furnace temperatures from infiltration and the reduction of back drafts reversing the gas travel and causing flame impingement on the stoker. This is quite prevalent with low furnace drafts, and especially liable to occur at the overfeed section, where combustion is accelerated and the fuel bed thin.

Velocity of the gases through the furnace is independent of the furnace draft but limited by the cross-sectional area of the furnace, the amount of gas and the temperature of the gas. Similarly, the velocity of the gases through the boiler is dependent upon the free area of the gas passages and the volume of the gases; in other words, upon the mass gas flow per square foot of free area in the boiler, and not upon the draft. To force a given volume of gas through the fixed free area of the gas passages requires a definite draft, so that the excess draft loss for the balanced draft condition through the boiler, shown by Mr. Houghton to be 0.07 in. greater (1.34 in. against 1.27 in.) is due to an increase in the excess air and an increase in the average gas temperature in the boiler.

I strongly agree with Mr. Houghton that modern stokers can be greatly improved with respect to the packing of coal in the retorts, and that is the reason for the better performance of underfeed stokers (on practically all coals) with overfeed sections compared to those where the retorts discharge directly to the dump plates or grinder; but changing the relative drafts will not improve matters in this respect.

Boiled down, this rule can invariably be followed: Operate with the thinest fires that will suit the coal characteristic and the variability of the load and which will maintain the highest CO_2 with the lowest ashpit loss. Use the least furnace draft that will permit of operation without local points of positive pressure.

Cleveland, Ohio. THEODORE MAYNZ.

Lay-Offs May Prove Costly to the Power Plant

IN POWER PLANTS where it is contemplated to retrench on the engineering staff it might be well to think twice before deciding on radical measures. In some cases, for example, where only one or two assistants were laid off, their continued employment might have saved the plants thousands of dollars. The chief engineer in all probability objected to their release, but the management insisted upon it. Had the management taken another view of the matter, reflecting that some of this help could be used to examine more thoroughly the entire plant's equipment and general conditions, some interesting work would have been possible.

Instead of laying off, it would be better to hold the matter in abeyance, and find out how the power plant really stands. Why not clean the plant thoroughly, so that it will be in spic-and-span shape, more inviting, and in better operating condition? Regarding possible repairs, considerable might be written.

Is the true condition of the boilers known? Are they as free of soot and scale as they should be? If any lay-off is going to affect any of the individuals responsible for the cleaning of boilers, such action may prove costly later.

In many power plants more spare time might wisely be applied looking to the condition of the furnace doors, the boiler settings, breeching, air leaks, loose and leaky joints in the power system, leaky valve stems and other unsafe, dangerous connections. And there will be hidden incipient troubles that will not come to light unless patiently sought. If these troubles are permitted to go on, there may be a costly break at a time when the management can least bear it.

Before laying off any men, consider what these men might account for by solving troubles, repairing engines, pumps, elevators, etc. Then there is the question of belting and chains. Lubrication is another important subject. Many power plants would do well to ponder whether their greases and oils really are of the best of the kinds required for each particular purpose and if they are being used properly and to the best possible advantage.

Weed out the defects in the power plant before contemplating the weeding out of any of the staff. Find where the equipment lacks, where things can be improved; repair, wherever necessary; tidy up and brighten up—thus preparing the plant for better days.

Brooklyn, N. Y. FRANK V. FAULHABER.

Personal Efficiency Important in Power Plant Operation

THE STEAM-MAKING equipment installed in the basement of a public building was first-class in every particular. The four horizontal return-tubular boilers were set over mechanically fired furnaces; automatic regulators adjusted the flow of feed water; a combustion recorder kept tab on the flue gases; recording steam and draft and temperature gages and a steam-flow meter contributed to the plant's refinements. Everything in the form of equipment was there to make the plant a model of efficiency. Yet it was not efficient. The monthly coal bill reached staggering proportions, while the flue-gas analyzer and the draft gages told a story of neglect and indifference on the part of the operating crew.

Smoke poured from the chimney and the apertures in the settings. The atmosphere throughout the building was so charged with coal gas as to cause complaints from the people at work. The chief engineer thought the coal he was getting might be at fault. So he demanded fuel of a better quality. But the better grade of coal gave off as much smoke as the poorer kind.

A gleam of inspiration finally struck the chief and he determined to do a bit of sleuthing. The schedule of operation required that all maintenance work on the boilers be done on the night shift. One evening the chief tied an inconspicuous black thread to the hinges of the smoke-arch door of one of the boilers, in such a manner that the thread would be broken if the door were opened. He then issued an order to the man in charge of the night shift to give the tubes in the marked boiler a thorough scraping. Next morning the night man's entry in the log book indicated that the work had been done in accordance with the instructions received. But the black thread was unbroken. Investigation showed the tubes to be literally plugged with soot.

This boiler plant had been rigged to secure high efficiency. But every precaution in that direction went for naught, because there was an absence of equal solicitude in picking the operating crew.

St. Louis, Mo. A. J. DIXON

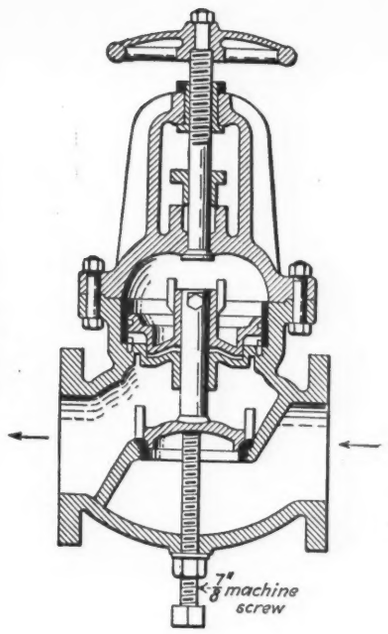
How a Stuck Non-Return Valve Was Forced Open

IN A central station that used an intermittent process of water softening considerable trouble was experienced with concentration in the boilers. The result was that at times there was a considerable carryover of solids with the steam. Upon occasions the condition was so bad that it interfered with the operation of the non-return stop valves, rendering them sluggish.

Once in particular, during the winter peak, one valve refused to open, throwing out of commission the boiler in connection with it.

Various methods employed to cause the valve to open proved unsuccessful. The boiler was needed badly and it was practically impossible to take steam off the section of the main header connected to the valve.

Finally, pressure was removed from the boiler and a hole was drilled and tapped through the bottom of the valve body, as shown in the illustration. Steam was again raised, and when the pressure reached approximately that of the header, the screw was turned, forcing the valve off its seat. Only a few turns of the screw were needed to start movement of the valve, which was finally opened to its full extent by the pressure.



Valve was forced opened by machine screw placed in bottom of valve body

After about one month's operation the valve was dismantled, cleaned internally and the hole in the bottom plugged permanently.

In an up-to-date installation one rarely finds a condition where it is impossible to take pressure off sections of a header to make repairs.

There was bad leakage of steam at the threads of the machine screw while it was being turned, but it was soon stopped by the improvised packing nut.

Louisville, Ky. JOHN F. HURST.

Velocity Indicator for Water Wall Tubes

IN THE Sept. 23 number, in an article detailing experiences with water walls at the Interborough Station, mention is made of a circulation indicator which was installed in the various tubes of the nearby horizontal water walls. Credit for this device was given to the engineers of Combustion Engineering Corporation.

It is to be inferred that this spinner or propeller wheel indicator is new, which is not the case. Bulletin No. 325. "A Study of Four Hundred Steaming Tests" made at the Fuel Testing Plant, St. Louis, Mo., in 1904-05-06, published by the Department of the Interior in 1907, reports experiments with just such a device, pictures of which are shown on page 161 of the pamphlet. The older mechanism differed only from that used at the Interborough Station in that it gave an electrical indication of revolutions rather than a visual one.

The St. Louis experiments were made on a water-leg type boiler and, although the upper rows of tubes were not exposed to radiant heat as in the water wall, a similar reduction in velocity was shown in the tubes above the bottom row. ELMER S. SMAIL.

Oak Park, Ill.

From Among Readers' Problems

Conducted by

L. H. MORRISON

SURFACE TENSION—*What is the meaning of "surface tension" as applied to a liquid?* R.B.T.

Surface tension is that characteristic of a liquid that causes it to act as if a tight membrane had been drawn across the surface, resisting, to some degree, the breaking of the surface. The phenomenon is due to the mutual attraction of the molecules of the liquid.

Within the body of the liquid the molecules exert attraction on each other, so that a single molecule is attracted on all sides by other molecules, or the net force causing a molecule to move becomes zero. But the molecule at the surface is not attracted by any molecule above it, so that there is a net force causing it to move downward toward the molecules immediately below it. As a result the top surface is more dense, and a steel needle will float on it if carefully deposited.

It is surface tension that causes a drop of water or oil to assume a spherical or spheroidal shape. This is because the internal attraction of the molecule tends to draw the liquid into the smallest possible volume, which is a sphere. The weight of the drop, however, causes the drop to flatten to a spheriod.

Surface tension may cause foaming in a boiler. If an impurity is added that increases surface tension, before a steam bubble moving upward toward the water surface is able to pierce this surface the steam pressure within the bubble must be higher than the pressure in the steam space. It then causes the water surface to rise, and when the bubble pierces the surface it immediately explodes, due to its greater interior pressure, carrying up with it some water. If the action is vigorous enough, the steam space will be filled with the mixture of water and steam. This action is heightened by the fact that each steam bubble is surrounded by a film of water having a surface tension sufficient to cause the bubble to maintain its form until it enters the steam space. Strangely, an impurity that settles on the surface reduces the surface tension, while others, like salt, will be taken up by the body of the water and increase the tension.

A Question for Our Readers

WE ARE operating three sawmills and using three different types of sawdust and hog fuel at each one. At one plant we are manufacturing gum wood which has a high moisture content.

We have been trying to find some way or means of drying this fuel before putting it into furnaces. Do you know of any method or device or system, whose operation is not too expensive, for drying of this type of fuel?

Suitable answers from readers will be paid for and published in the Dec. 23 number

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

THE 500-hp. diesel plant in which I am employed seems to cause severe vibration to surrounding buildings, and the owners of the buildings are complaining. The formation under the engine foundation consists of three feet of soft sand, six feet of quicksand, two feet of gumbo clay, more quicksand and another layer of clay, continuing this way until solid bottom, a bed of shale, is reached at 66 ft. W. C.

OF TWO or three effective methods of overcoming the severe vibrations, one in particular would be deemed the most simple and effective. This is to increase in area the spread of the present concrete foundation (which it is assumed consists of the present base) in proportion to the actual size in area of the present one. The additional spread should be as deep as the foundation and cover as much area as possible.

Another, but not quite so simple, way to eliminate the trouble is to drive spur piles alongside the base and down until hardpan is reached. The base should be drilled to a depth of approximately ten inches and dowels or iron bars of perhaps one inch in diameter and 24 in. long inserted. Then concrete should be poured to bind the entire mass into one solid block. This will have the effect of offering a substantial resistance to the vibrating foundation.

A false wall down to the clay would hardly be remedial, due to the fact that it would not have enough stability to eliminate the vibration.

ROBERT S. CROMLEY.
Lyndhurst, N. J.

THE OBVIOUS solution is to isolate the foundation from the clay, by excavating all around and piercing through the two feet of clay to reach, say, one foot into the quicksand underneath. The clay should be removed from under the foundation block all around for a distance of one foot at least, with the object of underpinning with concrete. This underpinning will be a section of concrete some 30 in. at the top, 36 in. at the bottom, and 36 in. high, having a battered face towards the excavation. Upon this battered face there should be applied four inches of corkboard in two-inch plys glued together and to the concrete with hot asphalt. The V-shaped cavity which remains between the clay and the battered face should be filled up with dry sand, and the excavation may be all back-filled with dry sand.

This solution should prove less expensive and more effective than a false wall around the engine foundation.

JUAN F. GONZALES.
Guayama, P. R.

I WAS CALLED to investigate, in 1922, a similar cast of vibration in the power station of the city of Kishinev, Bessarabia. It contained several horizontal 1,000-hp. diesels.

The vibration was so great that people in a hotel a few hundred yards away complained about not being able to sleep in the upper floors, several getting "seasick." All surrounding property owners complained; the vibration could be detected five to six blocks away.

Investigation showed that the foundation was not carried deep enough. The formation consisted of sand and wet clay in layers. Further, there was ground water to a depth of eight to ten feet during rainy seasons. Further investigation revealed that the foundation had moved in a horizontal direction. At certain definite periods, every 45 min. if I recall right, all the engines stroked in the same direction, causing a severe shock.

It was recommended to chip holes through the existing foundations at convenient places so as not to interfere with operation and drive prepared reinforced-concrete piles through these holes, and additional piles at the ends of the foundations. The foundations were about forty feet long. The piles were driven to about four feet above the existing foundation, then the concrete of the top of the piles was chipped away and the reinforcing rods of the piles bent down and interlocked with the existing foundation. The piles and the reinforcing rods were embedded in concrete and bonded to the existing foundation, which reduced vibration to a minimum.

Based on this experience, I should recommend that your piles, wooden or concrete, be driven around the foundation, which should have a tendency to hold the quicksand together. If this is not possible I suggest driving two rows of sheet piling around the power house, thus establishing a neutral zone between the two rows of sheet piling, which would prevent the vibration's travelling. This sheet piling should be driven down at least forty feet. A. T. HURTER,

Resident Engineer,
Abitibi Power & Paper Co., Ltd.
Iroquois Falls, Ont.

—❖—

ELIMINATION of the transmission of vibration from this engine can be effectively accomplished by isolating the engine block on both the bottom and sides with cork mats.

I recommend that the pit of the foundation block be extended down to the first layer of gumbo clay; then a three-foot well-reinforced concrete slab be poured for the sub-base. The sides of the pit should have concrete walls not less than six inches thick. The entire pit should be thoroughly water-proofed with either hot asphalt or asphalt emulsion, in this case. I should prefer the asphalt emulsion, because of the moist conditions. On top of the concrete slab four-inch cork mats should be used, and three-inch mats on the sides. The cork should then be protected with several layers of glossed water-proof paper, with the edges well overlapped and sealed before pouring the concrete mix for the engine block.

This is the method of isolation being used and recommended by many of the country's leading architects, engineers and engine manufacturers, and the one which has proved most successful in the greatest number of cases.

The recommended loading on natural cork is around 2,000 lb. per square foot, which is well within the safety margin, and seldom exceeded in installations of this type. H. B. VILLIERS,

L. Mundet & Son, Inc.
New York City.

—❖—

SUCH SOIL acts to a great extent similar to a liquid under the vibration caused by the engine. These vibration waves travel through the semi-liquid layers like sound travels through the air, and they may be felt at considerable distances.

The source of vibrations are the inertia forces of the moving parts of the engine, which I assume to be a vertical multiple-cylinder engine. Complete interbalancing (without counterweights) is possible with a six-crank engine with six equal pistons and connecting rods, the cranks arranged in three planes at 120 deg. angles symmetrically from the center of the engine. An air compressor forming part of such an engine may be balanced, in the same way as a one-cylinder engine, by means of counterweights on the crank. The counterweights will completely balance the revolving parts and partly balance the vertical inertia forces of the reciprocating parts. They introduce, however, some unbalanced horizontal inertia forces.

Under the given circumstances, vertical unbalanced forces will be more objectionable than horizontal, and by increasing the counterweights the vertical forces could be more completely balanced—increasing the free horizontal forces, however.

A four-cylinder engine cannot be interbalanced completely, as it is practically impossible to balance the secondary forces.

If the engine itself cannot be cured of vibrating, means should be found to reduce the amplitude. A false wall around the foundation down to the first layer of clay will probably not stand the stress. The quicksand under vibration, acting as a liquid, will exercise a pressure on the inside of this wall of one to two pounds per square inch in excess of the pressure on the outside, due to the weight of engine plus foundation. This may be sufficient to crack the wall, nullifying its effect. In addition, the wall would be expensive.

A better construction is the driving of piles closely around the foundation into the clay layer. The foundation can then be supported on these piles. The longer the piles and the more layers of clay they reach the more efficient this method will be.

Toronto, Can. J. P. WYS.

VARIOUS AUTHORITIES state that for horizontal single-cylinder engines the foundation should weigh not less than one ton per brake-horsepower for solid ground; therefore the foundation should weigh at least 500 tons. Concrete composed of one part concrete to three parts sharp sand and four parts stone weighs about 140 lb. per cubic foot. Therefore the total cubic feet of foundation directly fastened to the engine should be greater than $\frac{500 \times 2{,}000}{140}$ = 7,150 cu.ft.. A check should be made of the total number of cubic feet of concrete bolted to engine bed to see if it runs in excess of 7,150 cubic feet.

A seismic instrument like the amplitude meter built by the Vibration Specialty Company of Philadelphia, should be placed at various positions on the frame of the engine to find the direction and amplitude of the major vibrations. These values should be carefully mapped out and summed up, obtaining the maximum vertical and horizontal movements of the total engine mass. If the major movement is vertical and the mass of total foundation is proportioned as indicated above, a great amount of the vibration can be damped by raising the engine bed loose from its foundation and placing heavy felt under the engine bed and bolting down again.

If the major vibration is found to be in a horizontal direction it may be damped by concrete walling around the engine foundation down to the first clay layer and spacing this wall about four to six feet from the foundation and filling the space, preferably, with large smooth boulders of stone.

A. V. KILPATRICK,
Missouri School of Mines and Metallurgy.
Rolla, Mo.

—❖—

THE CONDITION is similar to that with which a factory in New York City had to contend. The ground at this plant is filled in and all of the building stands on piles. When this firm erected a diesel engine the vibration was so great that the tenants in the surrounding buildings complained, especially since the plant was running eighteen hours a day. After various attempts to eliminate or minimize the vibration, diggings were made down to the river bed, two feet beyond the engine bed. Piles were driven, overlaid with steel concrete and then capped with three feet of cork felt or mat. This left a two-foot moat all around the engine. Of course, there are steel plates covering these openings. It will be seen that there is no direct connection between the engine foundation and the plant or land proper, and vibration is at a minimum.

The suggestion of your inquirer regarding the erection of a false wall around the engine foundation appears to be answered in the above. A brick wall may act as a buffer, but I doubt it. It might act contrary to expectations.

S. ROSENBERG,
Inspector, Panama Canal.
New York City.

N.E.L.A. Hydraulic Power Committee Hears Reports of Progress in Its Field

IN CONJUNCTION with the regular meeting of the Engineering National Section of the National Electric Light Association at Montreal, Canada, the Hydraulic Power Committee held its sessions Oct. 6 and 7 with a record attendance. Reports were made by the various committees in continuation of the work that has been in hand over several years past and a number of these were authorized for publication.

J. D. Justin, chairman of the Committee on Fatigue of Metals and Penstocks, reported a continuation of its studies and concluded with the statement that material of importance will be available for the next meeting of the committee at St. Louis Feb. 16.

Revision of the report of the Hydraulic Turbine Governors Committee was reviewed, with particular emphasis upon the necessity of perfecting systems for frequency control. Necessity of keeping the reports of the committee up to date, and also in view of the rapid changes taking place in the art, led to the approval of a motion to appoint a standing committee whose duty it will be to report upon this important subject at each meeting.

An interesting discussion developed with respect to the improvement of frequency control in the selling of clocks which are operated directly from electric light sockets. Emphasis was laid upon the impropriety of the selling practices of some of the electrical clock companies which, without consideration of the problems of electricity generation and distribution, were advertising their wares in such a manner as to greatly complicate the dealings of some electric companies with their customers. As an instance, such an expression as "observatory time by wire" implied a degree of accuracy which the average electric clock and electric distribution system will find great difficulty in living up to.

It was reported for the Committee on Penstocks that the revision of the 1923 report is actively in hand and will be ready for publication shortly. A motion to appoint a standing committee to carry on and keep up to date the information on penstocks was passed. In connection with this discussion, the report of the Pennsylvania Electrical Association was discussed and favorably commented upon. This report, among other things, contains a list of 245 dam failures and their causes.

The report of the Committee on Vacuum Breakers was the source of a lively discussion which brought out the fact that in some cases the breaking of the vacuum reduced the power losses in units running as synchronous condensers from 25 per cent to as low as 1.6 per cent. Generally speaking, it is not satisfactory to put air directly into the draft tube, but better to introduce it into the top cover of the turbine case, and on some occasions even under slight pressure. Runner designs which provide cord spaces in hubs are an effective means of air introduction. It has been found at Back River that the quantity of air necessary to introduce decreases as the tail water level comes up, that is, as the draft head decreases. A pipe 10 or 12 in. in diameter is found necessary for the air inlet to a turbine unit having a 16 ft. diameter propeller-type runner.

The report of the Committee on Reliability of Hydro-Electric Units was discussed by its chairman, F. C. Ralston. An interesting discussion was held upon semi-automatic and automatic plants, in which, among other things, it was pointed out that electrical devices have been perfected to synchronize propeller turbines in one-fifth the time previously required. Mr. Woodward of the Woodward Governor Company reported research development on governors which had for their purpose the accomplishment of this same end.

Prof. E. Brown, chairman of the Committee on Waterwheel Welding, discussed a continuation of his report presented originally in March of this year and said he was in possession of records to show that turbines had been restored from 1½ to 4 per cent in efficiency after the runners were welded. A discussion of the metal electrodes most suited to the welding operation brought out some interesting points, from which it was generally developed that the use of chrome-nickel rods gives the best all around results. It was voted that Professor Brown's report be passed for publication and that his committee be continued.

Mr. Streiff of the Fargo Engineering Company reported for W. W. Teft, chairman of the Committee on Dams. This whole subject was recognized as one of such vast importance and interest to other engineering groups as well as the N.E.L.A. that the committee was requested to confer with such other interested groups and report back with recommendations as to proper procedure.

An interesting report on "Economics and Simplification of Hydro Plants" was abstracted by J. D. Justin, committee chairman. It is probable that this report will be passed for publication in the not distant future.

The report of the committee on Forecasting of River Flow was discussed at considerable length and its publication recommended.

Following the close of the formal sessions brief talks were made upon foreign practice, and Professor Angus of the University of Toronto was appointed chairman; the retiring chairman, Professor Brown, received a vote of thanks for past services.

A number of excursions to important plants followed the close of the meetings, there being a large number of visitors to the hydraulic works now under construction.

Wood Waste as Fuel

THE EFFICIENT feeding of wood waste under boilers requires a shredding or pulverizing operation, usually called hogging. Wood hogs are of two types, the knife hog and the hammer hog. The knife hog chops the blocks, strips and chips them into reasonably uniform slivers that can be mechanically conveyed and that will produce a practically uniform fire bed. The maintenance of knives is expensive, since nails and other hard particles of rubbish will dull the edges. Large blocks or crating cannot be hogged by the knife process. On the other hand, long, wet waste is more efficiently shredded in the knife type.

The hammer hog is an adaptation of stone-crusher design and literally pounds the wood into small particles. Having no sharp edges, the hammer hog is not harmed by any metals introduced with the wood waste.

The ground products of both types of hog are usually blown into large dust-collecting systems and stored in large bins or tanks near the boilers.

The steam value per pound of wood waste will range from 3.68 lb. at 65 per cent efficiency to 4.42 lb. at 78 per cent efficiency, with 4 lb. as a fair average for plants burning miscellaneous hogged wood waste with 6 to 8 per cent moisture content in boilers equipped with mechanical feeders.—From a paper by W. E. Biggs before the Wood Industries Division of the A.S.M.E.

✦

OPEN FEED HEATER EXPLODES—According to *The Locomotive*, a plant in Pleasant Hill, Mo., was recently closed down for twelve hours by the explosion of an open feed-water heater of cast-iron construction which was using exhaust steam from feed pumps and auxiliaries. Theoretically, it should not have been possible for excessive pressure to build up within the heater, for the apparatus was not only vented to atmosphere through a three-inch pipe in which there was no stop valve, but was equipped with a safety valve supposed to open at 15 pounds.

✦

PRODUCTION OF ELECTRICITY by the electric light and power industry of the United States for the week ended Saturday, Nov. 1, was 1,748,319,000 kw.-hr., according to the Statistical Research Department of the National Electric Light Association. This is 4.4 per cent below the figure for the corresponding week of 1929, but nevertheless 3.6 per cent above the figure for 1928. The Atlantic seaboard continues to register an increase in electrical output over last year, being 3 per cent above the same week of 1929. The great central industrial region, outlined by Buffalo, Pittsburgh, Cincinnati, St. Louis and Milwaukee, shows, as a whole, a decrease in electrical output of 7¼ per cent below last year.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Feed Pump Excess-Pressure Regulator Adjustable to Any Differential

AN UNUSUALLY simple and effective excess-pressure regulator for steam-driven boiler-feed pumps has been developed by the Mercon Regulator Company, Chicago, Ill., by substituting for the mercury column in the standard Mercon mercury-type regulator the control arrangement shown in the accompanying illustration. Steam pressure on one side of a diaphragm and the pump discharge pressure on the other side control the admission of steam to the driving turbine and therefore the speed and capacity of the pump. A needle valve in piping connections to the pump gives the advantage of an adjustable differential, which, however, remains constant for any particular setting of the valve, regardless of pump load or steam pressure.

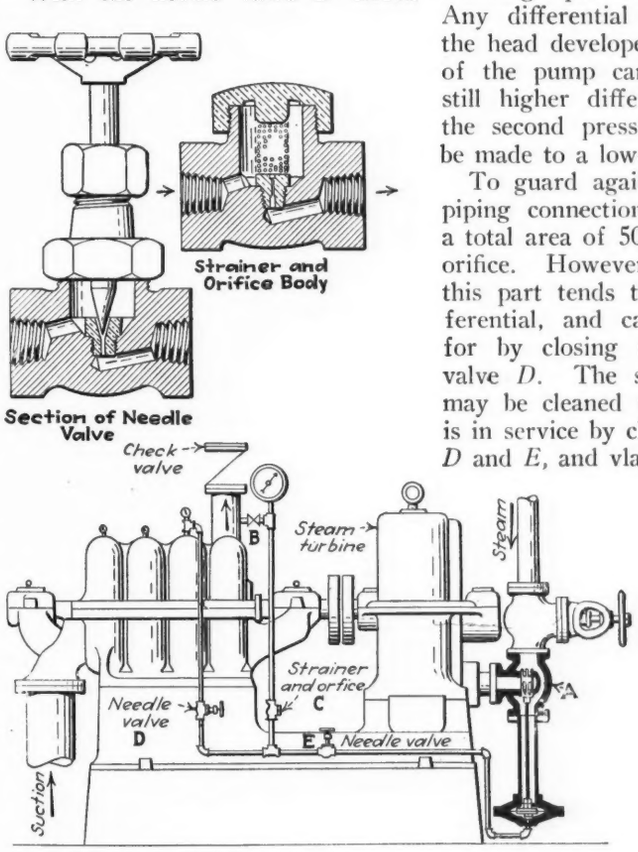
Reference to the illustration will show that the equipment consists of a steam control valve *A* of the angle, or globe, type installed in the steam line to the turbine. This valve is of the standard balanced-piston type operated by a thin diaphragm of relatively large area.

From the discharge of the pump or from some point in the feed header a $\frac{1}{4}$-in. pipe connection is made to the lower part of the diaphragm chamber. In this pipe are installed a globe, or gate, stop valve *B*, an orifice of small diameter protected by a strainer, as at *C*, and a needle valve *E*. Sections of the strainer and orifice body and of the needle valve are shown. To this line, between the orifice and needle valve, a pipe connection is made from one of the intermediate stages of the pump, usually the next to the last stage. In this latter connection is another needle valve *D* of the same type, as at *E*.

With the needle valve *D* closed and valve *E* open, the main steam throttle is opened, thereby applying full steam pressure above the diaphragm. This steam pressure forces the diaphragm downward and holds the control valve open until the pressure developed at the discharge of the pump is equal to that of the steam. When that occurs the diaphragm is balanced, and any further increase of feed-water pressure tends to close the steam valve and reduce the pump speed. The differential pressure is zero, that is, the feed-water pressure is maintained exactly equal to the steam pressure. If the needle valve *D* is opened slightly, some water will leak through it to the lower-pressure stage, thereby slightly reducing the pressure under the diaphragm, causing the steam valve to open and increase the pump speed until enough additional pressure is developed at the pump discharge to compensate for the leakage through valve *D* and thus again balance the pressures above and below the diaphragm.

Pressure at the discharge of the pump is then somewhat higher than formerly, and there will be a moderate differential of feed pressure above steam pressure. Opening the needle valve *D* wider will further increase the amount of control valve opening and consequently the pump discharge pressure and differential. Any differential between zero and the head developed by the last stage of the pump can be obtained. If still higher differential is required, the second pressure connection can be made to a lower stage.

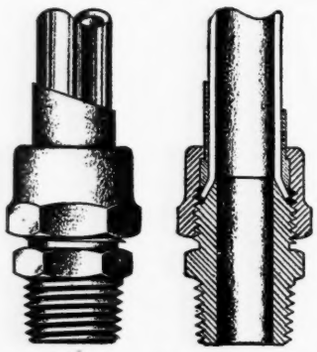
To guard against clogging in the piping connections the strainer has a total area of 500 times that of the orifice. However, any stoppage of this part tends to increase the differential, and can be compensated for by closing slightly the needle valve *D*. The strainer and orifice may be cleaned while the regulator is in service by closing needle valves *D* and *E*, and vlave *B*. The tubular strainer can be lifted out with the fingers, and by opening needle valve *D* a backwash under high pressure can be created to clear the orifice, or the orifice may be removed with a screw driver.



Turbine driven pump equipped for excess pressure regulation and sections through needle valve and strainer - equipped orifice body

Triple-Tube Coupling

DESIGNED to retain all of the features characteristic of Parker standard tube couplings and to meet installation conditions where entering the tube into the coupling body is inconvenient, the triple-tube coupling illustrated has been introduced by the Parker Appliance Company, 10320 Berea Road, Cleveland, Ohio. The new coupling does not displace the standard tube coupling but is used where installation conditions require it in conjunction with the standard type.



Coupling is made in standard and extra-heavy types

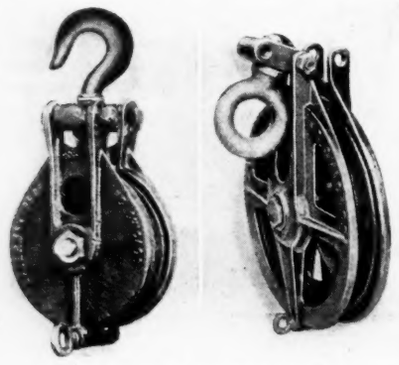
Component parts of the triple coupling lock tightly when the nut is screwed on to the body.

Improved Dragline Blocks

RECENT ADDITION to the line of "Durolite" steel dragline blocks put out by Sauerman Brothers, 438 South Clinton St., Chicago, Ill., makes available a wide range of sizes from 6 to 42 inches.

These blocks are built of special heat-treated alloy steel combining high strength with light weight. The flange of the sheave is protected by a heavy head on the housing that tends to prevent fouling and protects the cable. As shown in the illustration, the block can be opened up to receive or remove the cable by removing one pin from the yoke. Lubrication is through the sheave, a grease reservoir being provided around the bearing.

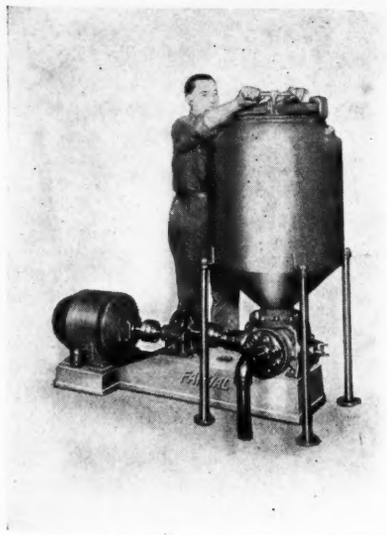
The blocks are furnished with either bronze-bushed or roller bearings, and with swivel hook, swivel rope bearing eye, or swivel pin bearing eye attachments.



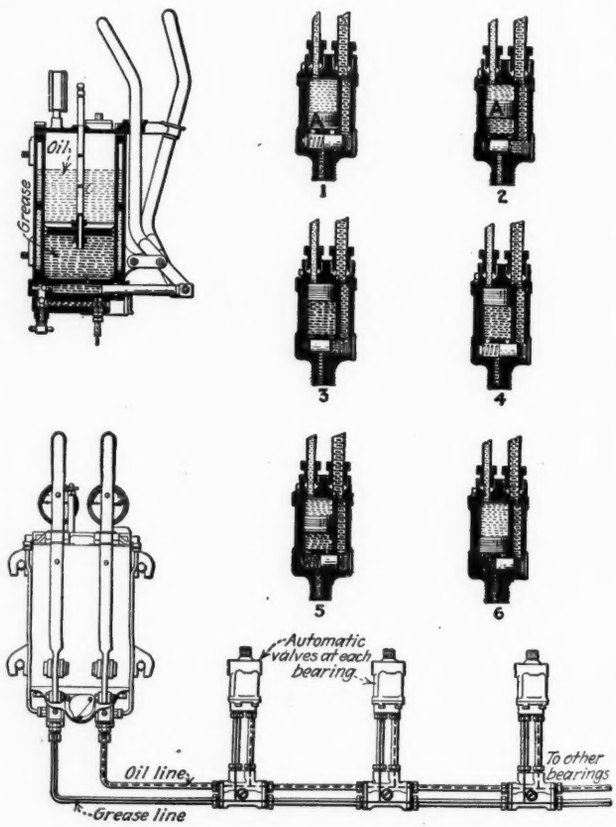
Two types of dragline blocks

Heavy-Duty Centralized System of Lubrication

THE "Dualine" system of lubrication recently introduced by Lubrication Devices Incorporated, Battle Creek, Mich., differs from the single system put out by this company in that two supply lines are connected to a measuring valve at each bearing. Referring to the illustration, the system consists of one central compressor and two main supply lines connected in series to a positive-piston-displacement type of measuring valve at each bearing. The central station consists of a double compartment reservoir serving two individual plunger type guns. One gun delivers the bearing grease to all valves connected to the one line and the other gun provides the necessary oil pressure to discharge all valves. The design of the valve and its principle of operation will be clearly understood from a study of the sectional views No. 1 to No. 6. These show a complete cycle of operation.



Motor-driven grease pump used with automatic electric system



Arrangement of central compressor with "Dualine" connection to measuring valve at each bearing

In supplying grease to the bearings, first the grease pump is operated until a pressure of 1,000 lb. registers on the gage. This pressure insures that all valves are filled with grease. Then the oil pump is operated until the same pressure is built up on the oil line leading to each valve. This oil pressure serves to operate the plunger *A* in each valve and to insure the grease's being forced into each bearing at high pressure.

In addition to the manually operated system illustrated, an automatic system is available in which the two central stations are electrically driven, with the frequency of operation controlled by an electric time clock. Any desired interval from two minutes to two hours can be had.

After the system has been started by the time clock the complete cycle of operation and the final shut off of both pumps is accomplished through the operation of the last valve at the end of the line. The grease pump and reservoir used with the automatic electric system is illustrated.

NEWS of the FIELD

Spot News

•

THE FIRST UNIT *of 50,000 kw. capacity was placed in operation Nov. 5 in the new steam-electric generating station of the Cleveland Electric Illuminating Company at Ashtabula, Ohio. The second and third units of similar size are nearing completion and will be placed in operation at an early date. The plant is designed for an ultimate capacity of 400,000 kw. in eight 50,000-kw. units.*

•

CONSTRUCTION *of a 50,000-kw. steam plant at Herndon, Calif., on the San Joaquin River, will be started immediately by the San Joaquin Light & Power Corporation, it has been announced. To cost about $4,610,000, the new generating station will burn natural gas from Kettleman Hills, which will be piped through a 12-in. main from Fresno. June 1, 1932, has been set as the date for completion.*

•

BRITAIN'S LARGEST UNIT, *a 50,000-kw. steam turbine-generator, has just been placed in service at the Portishead power station of the Bristol Corporation. The new unit brings the capacity of the plant up to 90,000 kw. It is designed for an ultimate generating capacity of 340,000 kilowatts.*

•

ACTUAL CONSOLIDATION *of northern California's gas and electric facilities into a $600,000,000 system was announced last week by Paul M. Downing, vice-president and general manager of the Pacific Gas & Electric Company. The merged system comprises 48 hydroelectric plants and 15 steam plants with a combined capacity of 1,500,245 hp., 33,204 miles of transmission and distribution lines, 800 miles of natural gas feeder pipe lines, and 6,000 miles of gas distribution mains.*

Growth of Stoker Applications Traced at Meeting of Manufacturers' Association

Used under 60 to 80 per cent of all water-tube boilers manufactured, President Worker states in opening address

INTERESTING STATISTICS on stoker applications were given in the opening address of the fall meeting of the Stoker Manufacturers' Association, held at the Homestead, Hot Springs, Va., Nov. 3 to 5, by the president, J. G. Worker of the American Engineering Company. Stoker sales for the first nine months of this year have been 64 per cent of those of the same period of 1929 and 73 per cent of those of the first nine months of 1928, he said. This corresponds closely to the record of boiler sales for the same period.

An estimate, he continued, was presented to the World Power Conference at Berlin this summer, showing the annual tonnage of coal fired under American boilers to be 450,000,000 tons of which 275,000,000 tons were fired by hand, 140,000,000 on mechanical stokers and 25,000,000 in pulverized form.

"All of the figures that I have been able to gather," stated Mr. Worker, "show that stokers hold a major position in their application to from 60 to 80 per cent of the water-tube boilers manufactured.

"Dr. Young of the Brookings Institution in collaboration with the Department of Commerce and the Bureau of Mines has given out reports that every kind of coal mined in the United States is burned in substantial amounts on stokers. These figures show that a total of 42,000,000 tons of coal were burned by public utilities in 1928 of which 34,000,000 tons were fired on some kind of stoker.

"We have increased the efficiency of stokers in the last ten years from 60 to 65 to 70 or 80 per cent, and with heat-recovery devices up to 90 per cent. It may be argued that not all of this saving is due to the innovations and designs brought about by stoker manufacturers, but a large percentage of this increase of efficiency should be credited to them. A difference of even ten per cent would mean a yearly saving to the public utilities of at least 4,000,000 tons of coal, amounting to $20,000,000 at $5 per ton."

He urged some sort of orderly method of getting facts relative to the stoker industry before the people, as through a public policy committee which would voice the concerted opinion of the members rather than the beliefs of individual members.

"There is a demand for bigger and better stokers," he asserted. "There is an astonishing demand for small automatic stokers."

Contemplating that the association would be called upon for a combined statement of the number of men employed, in the current efforts to relieve unemployment, he recommended this as a topic for consideration.

Stoker Scholarship Suggested

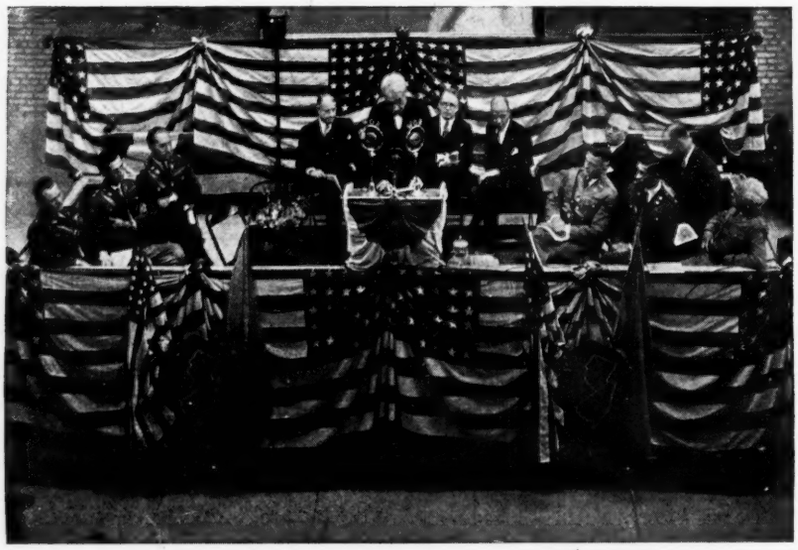
For the benefit of the young men who are choosing stoker work as their profession, he suggested the establishment of a scholarship at one of the universities. The publicity committee also might offer prizes for the best papers submitted regarding stokers and stoker practice, which papers might be made subjects of discussion at the meetings of the association.

Several representatives of the small stoker branch of the industry were present by invitation and much of the time of the meeting was devoted to discussing possible co-operation. A considerable group of the companies manufacturing this type of stoker are, or are expected, to become members.

On Tuesday forenoon reports were heard from the engineering, commercial, publicity and other committees and on Wednesday reports from the committee on Department of Commerce reports, which was authorized to somewhat extend the data furnished the contact committee with the boiler manufacturer and the membership committee. F. R. Low, editor emeritus of *Power*, concluded the program with some brief impressions of Stoker Manufacturers' Association meetings. Appreciation of the multiple services of President J. G. Worker was then expressed by a rising vote.

The next fall meeting is slated for Sea View, N. J.

DEDICATION OF SOUTH AMBOY



Martin J. Insull, president of the Middle West Utilities Company, delivering the dedication address at the opening on Oct. 31 of the Jersey Central Power & Light Company's new 50,000-kw. generating station at South Amboy, N. J. Seated in back of Mr. Insull are Governor Larson of New Jersey who threw the switch that placed the plant in operation; T. R. Crumley, president of the Jersey Central company, and A. E. Burns, vice-president of the National Electric Power Company, who supervised the construction of the plant. One of six central stations in the United States now operating at 1,200 lb. pressure or over, South Amboy is designed for an ultimate capacity of 300,000 kw.

▼ ▼ ▼

Call for Bids on Hoover Dam to Be Issued Dec. 1

The Department of the Interior announces that it expects the specifications for Hoover Dam to be ready by Dec. 1 and that a call for bids for the great undertaking will be issued at that time. The first of the tasks at the damsite will be that of driving four tunnels, each 50 ft. in diameter and about one mile long, through the solid volcanic rock cliffs on each side of the canyon. These tunnels alone will cost from 15 to 20 million dollars.

The initial task at the actual damsite will be to remove from the bed of the river the loose boulders and dirt that lie above bed rock. This loose material is from 100 to 150 ft. thick and it will be a Herculean task to sweep the bed rock clean of it. Not until the tunnels are completed, the river diverted, and the bed rock exposed can the actual construction of the dam itself begin. Starting at bed rock this great concrete structure, 650 ft. long at the base, sloping to a width of 45 ft. at the top will begin to arise to its ultimate height of 727 feet.

Originally it was thought that it might be wise to let the different items in this final undertaking of dam construction to different contractors. One firm might drive the tunnels on one side of the canyon and another firm those on the other side. A different contractor might build the cofferdam, might excavate for the great dam, might erect that dam. After careful study and consultation with the leading contractors of the nation, however, it was decided that this entire undertaking, through the elimination of duplication, could be more economically handled as a single project.

The bids for this huge contract will call for the expenditure of 60 to 70 million dollars. Not many contracts of this size have been let in the history of the United States.

Ninety days will be given contractors to submit their bids. The contract, therefore, is expected to be let about March 1. In the meantime the preliminary contracts bringing transportation to the damsite, providing power, living quarters, water supply, etc., will have been executed.

Washington G. & E. Acquires Low-Cost Steam Plant

Washington Gas & Electric Company, one of the principal subsidiaries of North American Gas & Electric Company, has just acquired the power production facilities and transmission system of the Long-Bell Lumber Company at Longview and Ryderwood, Wash.

The property includes a 24,000-kw. modern steam generating station located on the Columbia River, together with about 35 miles of 66,000-volt transmission line and substations with an aggregate capacity of 20,000 kw. The power plant, which produces more than 100,000,000 kilowatt hours of electrical energy per year, utilizes as fuel saw mill refuse and oil and is one of the lowest cost producers of steam-generated energy in the United States.

Long-term contracts for the purchase of fuel have been entered into with the Long-Bell Lumber Company, which will purchase all its power and steam from the Washington Gas & Electric Company.

Regulation of Utilities Necessary, Says Hughes

Government regulation was described this week by Charles Evans Hughes, chief justice of the United States Supreme Court, as a necessity in reconciling the multiplying and complex interests of the community, considered nationally or locally, and the requirements of private initiative and individual liberty. The remarks of the chief justice were addressed to the Association of Practitioners before the Interstate Commerce Commission at its first annual convention in Washington. Mr. Hughes said that if the Interstate Commerce Commission, which dates from 1887, had been established much earlier, with adequate authority, "we should have been spared many of the most difficult of our present problems."

Mr. Hughes' address followed closely upon wide publication of an advertisement by the Associated Gas & Electric System inveighing against "the deadening hand of regulation" and predicting that proposed federal regulation of public utilities would drag them into the same financial straits that are embarrassing the railroads.

"To continue its progress in serving the public," said Associated Gas, "the American utility industry must be left with a free hand."

Noting that it was a long time before public opinion could be sufficiently convinced of the need of administrative agencies with broad powers in order to enforce standards which legislatures found it impracticable to apply directly, Mr. Hughes said that it has been characteristic of our civilization that adaptions of the legal structure are generally belated.

"We now recognize fully," said the chief justice, "the need of continuous and expert investigations, not ex parte or biased by political motives, but impartial and with full and fair hearings and competent discussion. Now we have provided, in nation and states, a host of administrative agencies, and we realize that we have thus been brought to the severest test of the republic, that is, its ability to draw to the complexities of administration the comprehensive knowledge and technical skill, and above all, the reasonableness which will give us the desired fruits of regulation and avoid both the indifference of routine and the arbitrariness of an unintelligent or despotic bureaucracy."

State Officials to Discuss Problems of Utilities

Utility problems will be discussed by power company and government officials at the forty-second annual convention of the National Association of Railroad and Utilities Commissioners, to be held at Charleston, S. C., on Nov. 12-15. Federal or state regulation of utilities, the natural gas problem, government and municipal operation of utilities and other subjects will be considered at the meetings.

At the sessions on Nov. 12 Senators Cole Blease and Ellison D. Smith of South Carolina will deliver addresses, and Alexander Forward, managing director of the American Gas Association, will discuss "The Natural Gas Problem." "Federal or State Regulation" will be the subject of an address, Nov. 13, by William Chamberlain, president of the United Light & Power Company, of Chicago. The chairman of the Indiana Public Service Commission, J. W. McCardle will speak on "Government and Municipal Operation of Utilities and Other Properties." William A. Prendergast, former member of the New York Public Service Commission, will deliver an address, Nov. 14, on "Principles v. Opportunism in Rate Making."

Revised Code Available for Pulverized-Fuel Systems

Copies of the American standard, "Safety Code for the Installation of Pulverized-Fuel Systems," are now available to the public and may be obtained at five cents a copy from the American Standards Association, 29 West 39th St., New York City, it was announced last week by the association.

The provisions of the code as adopted by the National Fire Protection Association were published in *Power* for July 22.

Western States and Cities Vote on Power Issues

By a vote of approximately one and a half to one, measures looking toward the formation of utility districts for public development and management of power plants were passed at the general election in Oregon on Nov. 4. The overwhelming majority vote cast for Julius L. Meier and other state officials whose platforms centered largely around various phases of public ownership, is another reflection of public attitude in the state on the power issue. In addition Ralph C. Clyde, aggressively in favor of municipal ownership, received a large plurality for commissioner of Portland.

Likewise, the State of Washington voted in favor of the district power bill, which creates public utility districts for the purpose of building, acquiring through condemnation, or purchasing power plants and distribution systems to be operated by state agencies.

In California the election went the other way. San Francisco voters decisively defeated the proposed measure creating an elective municipal public utilities commission by a vote of 73,480 to 37,603. The Los Angeles power bond issue of $13,300,000 for the construction of power facilities failed to obtain the two-thirds majority required for passage, the vote from 1,835 out of 1,852 precincts being 124,736 yes and 102,106 no.

Norwich (Conn.) Organizes A.S.M.E. Section

With a charter membership of 37, the Norwich Section of the American Society of Mechanical Engineers was formally organized on Oct. 29 at a dinner meeting in Norwich, Conn. William H. Buck of the Aspinook Company, Jewitt City, largely through whose efforts the local section was formed, was selected as permanent chairman. Other officers chosen were: secretary, E. Lovelock Holm, chief engineer of the Inland Paper plant; treasurer, Clarence E. Barber, chief engineer of the Norwich State Hospital; executive committee, Philip A. Johnson, Russell Clapp, Jr., and Walter E. Beaney.

News of Canada

Chats Falls progressing rapidly—Ontario gains control of Mississaugi River—Notch hydro completed

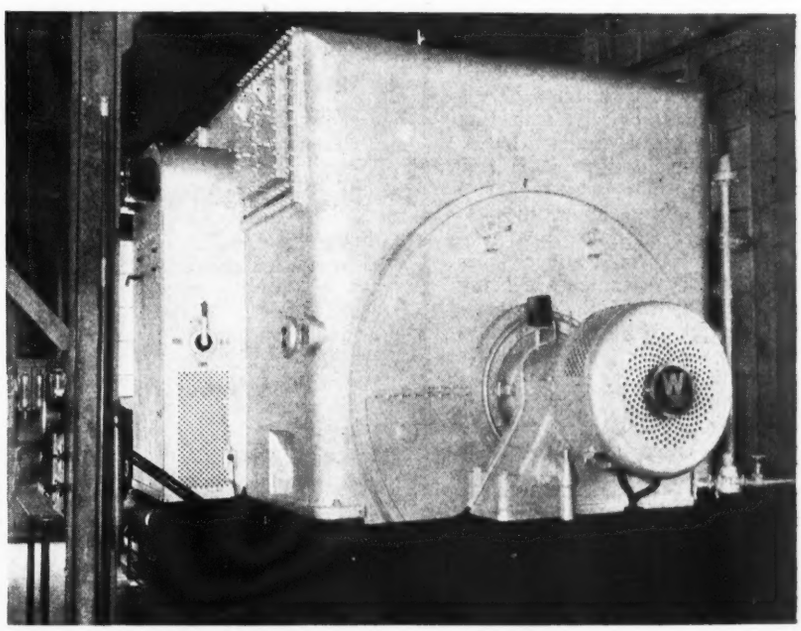
GOOD HEADWAY is being made with the 224,000-hp. hydro-electric development at Chats Falls, on the Ottawa River, about 35 miles above the city of Ottawa. Placing of concrete in the main dam and at the power-house site is progressing rapidly. A modern concrete and crushing plant is installed and in operation, designed to turn out 1,500 cu.yd. of concrete a day. To date 60,000 cu.yd. of concrete have been placed.

The name of the company developing the Quebec portion of this project has been changed from the Chats Falls Power Company to the Ottawa Valley Power Company. The power development on the Ontario side of the interprovincial scheme is being carried out by the Ontario Hydro-Electric Power Commission and the main dam across the river will be owned jointly by the company and the commission. All primary power generated by the company will be absorbed by the Ontario Hydro under a 40 year contract.

COMPLETION of an agreement between the Ontario Government, the Algoma Central Railway and the Al-

▼ ▼ ▼

LARGEST HYDROGEN-COOLED UNIT



This 9,375-kva., 80 per cent power factor turbine-generator, recently completed by the Westinghouse Electric & Manufacturing Company, is 25 per cent more powerful than an ordinary unit of its size because it is cooled by hydrogen instead of air. Such a generator is almost unheard of since, unlike the self-contained hydrogen-cooled synchronous condensers, its shaft must extend outside the hydrogen chamber

goma District Power Company, in regard to the long dispute over the power sites on the Montreal River, 92 miles north of Sault Ste. Marie, has been announced. Under this agreement the Algoma District Power Company is given the right under lease to develop the upper and lower falls of the Montreal River subject to government control. In return, the company has definitely surrendered to the provincial government its ownership of the Grand Portage Falls on the Mississaugi River and its power site and power rights in the tunnel site, on the same river. This arrangement reinvests in the province a substantial control of the power situation on the Mississaugi.

THE Canada Northern Power Corporation has completed its Notch power plant on the Montreal River, 15 miles from Cobalt, and delivery of power from this unit is expected soon. The initial installation comprises 13,000 hp., though the site is capable of being developed to 45,000 hp. Operation of the Notch plant will bring Canada Northern Power's total capacity to 114,000 hp. divided between ten plants, of which the Quinze station with a development of 47,000 hp. is the largest.

▼

How's Business?

AS THE COUNTRY impulsively mobilizes its generosity to tide over a hard winter by an improvised dole system and roundabout inflation, business is sliding further into the final stage of depression, under the weight of still unbroken financial fatalism, business inertia and popular fear. Our preliminary index for the week ended Nov. 1 fell further, from 83.4% of normal to 81.5%, reflecting continued relaxation of industrial activity and primary distribution. The strange and disturbing thing about the situation is that those who can least afford to take any chances or make any sacrifice are being exhorted to take the initiative of investing their uncertain purchasing power in business restoration, while those upon whom the real responsibility rests are not taking any. The public is responding to "Buy Now" campaigns and demonstrating the latent consumptive capacity of the market; but neither business enterprise nor financial support are forthcoming to reciprocate this gesture of confidence by supplying the goods, and thereby justifying it through expanding employment. — *The Business Week*, Nov. 12.

▼

▼

With the SOCIETY SECTIONS

A.I.E.E., Boston Section. Meeting at the Walker Memorial Building, M.I.T., on Nov. 18 at 6:30 p.m. Subject: "Louisiana Power Station of Louisiana Steam Products, Inc.," by J. F. McLaughlin of Louisiana Steam Products, Inc., and C. R. Stewart, W. L. Locke and H. J. Klotz of Stone & Webster.

A.S.M.E., Buffalo Section. Afternoon meeting at the Red Coach Inn, Niagara Falls, N. Y., on Nov. 22 at 2 p.m. Inspection trip through Niagara Falls Power Company Plant, followed by talk on "Separation Problems in the Process Industries," by E. M. James of the Sharples Specialty Company.

A.S.M.E., Metropolitan Section. Meeting in Room 501, Engineering Societies Building on Nov. 12 at 8 p.m. Subject: "Exhaust Gas Boilers for Diesel Engines, in Stationary, Railroad and Marine Services," by Thomas Clarkson of London, England.

A.S.M.E., Schenectady Section. Meeting on Nov. 13. Subject: "Photography as Applied to Engineering Problems," by G. E. Matthews of the Research Laboratory of the Eastman Kodak Company.

A.S.M.E., Worcester Section. Meeting at the Aurora Hotel on Nov. 19 at 6 p.m. Subject: "Generation of Power by Steam," by Elmer Smith, turbine specialist of the General Electric Company.

A.I. & S.E.E., Philadelphia Section. Meeting at the Engineers' Club on Dec. 6 at 7 p.m. Subject: "The Influence of Modern Electrical Equipment Design on Brush Performance," by William Siebenmorgen of Electro Service, Inc.

A.W.S., New York Section. Meeting at the Engineering Societies Building on Nov. 18 at 7:45 p.m. Symposium on "Present Status of Structural Welding Throughout the United States From the Standpoint of Application and Regulation."

A.W.S., Boston Section. Meeting at the Thomas Gibb Electric Welding Company in Lynn, Mass., on Nov. 14 at 7:30 p.m. Subjects: "Welding of Motor Magnet Frames," by M. Thomson of the General Electric Company; "Seam Welding," by W. T. Ober of the Thomas Gibb company, followed by demonstrations of the various types of welding machines.

Plant Engineers' Club, Boston. Meeting at the University Club on Nov. 19 at 7:30 p.m. Subject: "Modern Steam Generation," by J. H. Rohrer of the Badenhausen Corporation.

▼

Obituary

CHARLES H. CARROLL, president of the Shaw Kendall Engineering Company of Toledo, Ohio, died suddenly on Oct. 4. Mr. Carroll was 58 years old and had been president of the company for eight years. He was one of the founders of the Toledo Pipe Threading Machine Company. Interested in many engineering projects, he was one of the most prominent figures in industrial Toledo.

ADDISON H. BEALE, president of the A. M. Byers Company of Pittsburgh, Pa., died on Oct. 28.

Personals

V. L. MALEEV, formerly consulting engineer for the Western Enterprise Engine Company of Los Angeles, Calif., is now professor of mechanical engineering in the Division of Engineering of the Oklahoma Agricultural and Mechanical College at Stillwater.

ROGER DEWOLF, formerly assistant superintendent of the Rochester Gas & Electric Corporation, has been named superintendent of steam power distribution at Reading, Pa., by the Associated Gas & Electric Company. E. R. CROFTS, formerly purchasing agent of the Rochester company, will succeed Mr. DeWolf.

FRANK W. PEEK, JR., chief engineer of the transformer engineering department of the General Electric Company at Pittsfield, Mass., has been elected a director of the American Institute of Electrical Engineers to fill the vacancy occasioned by the election of WILLIAM S. LEE to the presidency of the institute.

C. E. BENNETT, general engineer of the Georgia Power Company and formerly manager of the electric department of that company, has resigned to become special research engineer for the Okonite Company with headquarters at Paterson, N. J. Mr. Bennett has been with the Georgia company for nearly nineteen years, with the exception of the time during the war when he was associated with Hugh L. Thompson of Waterbury, Conn., in charge of the design and construction of industrial power houses and substations for the Scoville Manufacturing Company.

DONALD R. DOHNER, former instructor in design at Carnegie Institute of Technology, was recently appointed director of art for the Westinghouse Electric & Manufacturing Company to assist in carrying out the new plan of the company for incorporating fine appearance as well as mechanical perfection in the design of electrical machinery.

SILAS L. GILLAN, consulting engineer, has been elected president of the Engineers' Club of Los Angeles, Calif., succeeding PAUL OVERTON. Other officers for the forthcoming year are: first vice-president, HARRY L. CALDWELL, engineer in the Los Angeles Department of Water and Power; second vice-president, THURSTON H. ROSS, member of Ross, Smith, Leonard & Company; secretary-treasurer, LE ROY C. WILLIAMS, of the Pacific Electric Manufacturing Company.

LEE F. ADAMS, commercial engineer of the General Electric Company at Schenectady, N. Y., has been awarded the manufacturers medal and purse for 1930, given under the James H. McGraw Award.

Business Notes

CARRIER ENGINEERING CORPORATION of Newark, N. J., BRUNSWICK-KROESCHELL COMPANY of New Brunswick, N. J., and YORK HEATING & VENTILATING CORPORATION of Philadelphia, Pa., three of the largest concerns in the heating and ventilating field, have practically completed negotiations for merging. Including subsidiaries, the merger will unite fifteen companies, five of them foreign, with total assets of approximately $15,000,000.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, East Pittsburgh, Pa., announces that orders received during the nine months ended Sept. 30 amounted to $132,715,293 compared with $185,625,135 for the corresponding period of 1929. Sales billed totaled $137,446,908 compared with $159,545,778, and net profit amounted to $11,352,244 against $19,544,211 for the first nine months of 1929.

FRANCE PACKING COMPANY, Tacony, Philadelphia, Pa., announces the opening of its Chicago district office at 1344 Washington Boulevard. John H. McKenna is in charge of the new office.

AMERICAN BAUER WACH CORPORATION, New York City, announces a reorganization of the company with the following officers: President, F. W. Kennedy; vice-president, James S. Milne; treasurer, L. S. Rice, and secretary, H. L. Watson.

IRONTON FIRE BRICK COMPANY, Ironton, Ohio, announces the opening of a district sales and service office at 1409 Fletcher Savings & Trust Building, Indianapolis, Ind. Carl E. Von Luhrte is in charge of the new office.

AMERICAN WATER SOFTENER COMPANY, Philadelphia, Pa., announces that the license agreement for the manufacture and sale of lime and soda softeners with Paige & Jones Chemical Company has been terminated and that in the future it will manufacture and furnish direct to consumers the equipment formerly manufactured and sold by Paige & Jones. The American company will also furnish repair parts and service to users of Paige & Jones equipment.

AMERICAN MANGANESE STEEL COMPANY, Chicago Heights, Ill., announces the appointment of the Southern Tractor Supply Company, 406 Geer Building, Durham, N. C., as exclusive representatives for the sale of its crawler-tractor links and sprockets in the District of Columbia, North and South Carolina, eastern Tennessee, Virginia and West Virginia.

HENSZEY DE-CONCENTRATOR COMPANY, Watertown, Wis., announces the appointment of the Beeson Engineering Company, Ltd., 315 West 9th St., Los Angeles, Calif., as its sales representative for that territory.

▼

Coming Conventions

American Society of Mechanical Engineers. Annual meeting in New York City, Dec. 1-5. National Fuels Meeting in Chicago, Ill., Feb. 10-13, 1931. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting at Louisville, Ky., Nov. 19-22. Annual Winter convention in New York City, Jan. 26-30, 1931. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Heating and Ventilating Engineers. Annual meeting at the William Penn Hotel, Pittsburgh, Pa., Jan. 26-29, 1931. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

American Society of Refrigerating Engineers. Annual meeting at the Hotel New Yorker, New York City, Dec. 3-6. Secretary, David L. Fiske, 37 West 39th St., New York City.

International Acetylene Association. Annual convention at the Congress Hotel, Chicago, Ill., Nov. 12-14. Secretary, A. C. Morrison, 30 East 42nd St., New York City.

Midwest Power Engineering Conference and Exposition. Fifth meeting in Chicago, Ill., Feb. 10-13, 1931. Secretary, George E. Pfisterer, 308 West Washington St., Chicago, Ill.

National Association of Practical Refrigerating Engineers. Annual convention and exhibition at the Hotel Peabody, Memphis, Tenn., Nov. 11-14. Secretary, Edward H. Fox, 5707 West Lake St., Chicago, Ill.

National Power Show. Grand Central Palace, New York City, Dec. 1-6. Manager, Charles F. Roth, Grand Central Palace, New York City.

▼

Trade Catalogs

VALVES—A new 754-page cloth-bound catalog (No. 88) and data book on valves, fittings, tools and pipe for steam, water, gas, oil, air, and other liquids and gases, has just been published by the Walworth Company, Statler Building, Boston, Mass. Besides illustrated descriptions, dimensions and prices of the various products, the book contains engineering information of great value, including tables never before published of the flow of water through pipes and the different pressures corresponding to different heads; tables of discharging capacities and friction loss in pipes; steam tables and other data.

FURNACES—Illustrated bulletin describing zoned water cooling and armored furnaces as developed by the American Engineering Company, Aramingo and Cumberland Sts., Philadelphia, Pa.

STOKERS—Two bulletins, "Taylor Stokers" and "Burning Coal the Modern Way on Taylor Stokers," illustrating and describing construction details and installations of the stokers manufactured by the American Engineering Company, Aramingo and Cumberland Sts., Philadelphia, Pa.

STRAINERS—Bulletin No. 9-S, illustrated, covering the SK line of strainers for oil, steam, water, etc., Schutte & Koerting Company, 12th and Thompson Sts., Philadelphia, Pa.

MOTORS—Bulletin No. 109 illustrating and describing Type AA squirrel-cage induction motors for two- and three-phase circuits, Reliance Electric & Engineering Company, Ivanhoe Road, Cleveland, Ohio.

▼

Fuel Prices

FUEL OIL

New York—Nov. 6, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Oct. 30, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.345 per bbl., or 42 gal.; 26@28 deg., $1.47 per bbl.; 28@30 deg., $1.595 per bbl.; 30@32 deg., $1.695 per bbl.; 32@36 deg., gas oil, 4.026c. per gal.; 38@40 deg., distillate, 4.651c. per gal.

Pittsburgh — Oct. 30, f.o.b. local refinery, 34@36 deg., fuel oil, 3.87½c.@4c. per gal.; 36@40 deg., 3.75c.@4c.

Philadelphia — Nov. 5, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati — Oct. 28, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Oct. 30, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 70c. per bbl.; 26@30 deg., 90c.@95c. per bbl.; 30@32 deg., $1.05 per bbl.

Boston—Nov. 3, tank-car lots, f.o.b. 12@14 deg., Baumé, 3c. per gal.; 28@32 deg., 5c. per gal.

Dallas—Nov. 1, f.o.b. local refinery 26@30 deg., $1.10 per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.90 @ $2.25
Pool 10, hr.gr. low-vol.	New York	1.75 @ 1.85
Pool 11, low-vol.	New York	1.60 @ 1.75
Smokeless, mine-run	Chicago	1.75 @ 2.25
Smokeless, slack	Chicago	.50 @ 1.35
Harlan, Ky., slack	Chicago	.50 @ .90
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.20 @ 1.60
Ind. 5th Vein, m.-r.	Chicago	1.50 @ 1.85
Standard Ill., mine-run	St. Louis	1.50
W. Ky., mine-run	Louisville	1.00 @ 1.25
W. Ky., slack	Louisville	.25 @ .50
Pittsburgh, mine-run	Pittsburgh	1.30 @ 1.60
Smokeless, mine-run	Cincinnati	2.00 @ 2.25
Smokeless, slack	Cincinnati	1.00 @ 1.35
Kanawha, mine-run	Cincinnati	1.10 @ 1.35
Kanawha, slack	Cincinnati	.30 @ .50

Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.00
Barley	New York	1.15@1.50

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Herndon—San Joaquin Light & Power Corp., Power Bldg., Fresno, will build a 50,000 kw. steam-operated generating plant burning natural gas. Estimated cost $4,000,000. H. K. Fox, c/o owner, is engineer. Work will be done by owners forces.

Calif., Los Angeles—Union Pacific R.R. Co., 15th and Dodge Sts., Omaha, Neb., awarded contract for the construction of a 7 story, 100 x 620 ft. warehouse including cold storage facilities, etc. at 9th and Alameda Sts. here to J. V. McNeil Co., 5860 Avalon Blvd., Los Angeles. Estimated cost $3,500,000. G. J. Adamson, Omaha, Neb., Ch. Engr.

Calif., Santa Rosa—Pacific Gas & Electric Co., 245 Market St., San Francisco, is having plans prepared for the construction of a warehouse, transformer house, meter house, service buildings, etc. here. Estimated cost $60,000. Private plans.

Conn., Hartford—Bd. of Contract & Supply, will receive bids until Dec. 9 for the construction of a pumping station in connection with dike and flood project. Estimated cost $145,000. R. Clark, City Hall, is engineer.

Ind., Fort Wayne—City is having plans prepared for extensions and improvements to waterworks including reservoir, filtration plant, pumping station, etc. Estimated cost $2,750,000. Hoad, Decker, Shoecraft & Drury, Ann Arbor, Mich., are engineers.

La., New Orleans—Sewerage & Water Bd., will receive bids until Dec. 30 for extension to drainage pumping station No. 7 at Florida Ave. and Orleans St. Estimated cost $170,000.

Mich., Detroit—Borin Bros. Coal & Ice Co., 1635 Westminster Ave., is having plans prepared for the construction of a dry ice plant, 30,000 lb. daily capacity, on Linwood Ave. Estimated cost $400,000. Private plans. Electric motors, etc., will be required.

Mich., Detroit—Dept. of Public Works, will soon award contract for sewage treatment work including pumping station, two 2,700 g.p.m. pumps, etc. P. A. Fellows, City Hall, is engineer.

Minn., Minneapolis — Bd. of Park Commissioners, City Hall, will soon award contract for waterworks improvements to include drilling of four wells, etc. A. E. Berthe is engineer.

Mo., St. Louis—St. Louis University c/o R. Johnston, 221 South Grand St., will receive bids about Dec. 15 for the construction of a 14 story hospital including power house, etc. Grand Blvd. between Vista and Rutger Sts. Estimated cost $1,000,000. Study & Farrar, 1363 Arcade Bldg. and A. J. Widmer, 1217 Fullerton Bldg., are associate architects.

N. J., Montclair—Public Service Production Co., 80 Park Pl., Newark, postponed construction of boiler house, garage, shop, etc., at 101 Greenwood Ave. here. $150,000. Maturity indefinite.

N. J., Trenton—Dept. of Institutions & Agencies, State Office Bldg., Annex, awarded contract for the construction of a 1 story, 45 x 90 ft. power house at New Jersey State Prison to J. H. Morris & Co., 211 Montgomery St. Estimated cost $40,000.

O., Canton—Canton Ice & Fuel Co., 1210 3rd St. N. E., plans a 2 story addition to ice plant to double present capacity. Estimated cost $50,000. Private plans. Machinery and equipment will be required.

O., Dayton—Schenck & Williams, Third National Bldg., Archts., will receive bids until Dec. 3 for the superstructure of a 20 story bank and office building, including steam heating and ventilation systems, boilers, elevators, etc., on West Second St., for Mutual Home & Savings Association, Second and Main Sts. Estimated cost $1,000,000.

Ore., Crescent Lake—Odell Lake Co. has made application to Federal Power Commission for permit to construct a 40 hp. development on Odell Creek in Klamath County to be used for lighting and power purposes at a lake side resort.

Okla.,—City plans an election soon to vote $300,000 bonds for the construction of a 2,500 hp. Diesel engine electric light plant. G. Estey, is engineer.

Ore., Portland—N. B. Craver, has made application for permit to appropriate 500 sec.ft. of water from Clackamas River for development of 1,000 hp. Estimated cost $100,000.

Pa., **Oil City**—Keystone Public Service Co., V. A. Redfield, Gen. Mgr., Drake Theatre Bldg., plans the construction of an electric power plant. Engineer not selected. Probably will not mature for about two years.

Pa., Pittsburgh — Bd. of County Commissioners, received low bids for the installation of a complete water system including pump houses, pumps and motors, etc. E. A. Griffith, 519 Smithfield St., is engineer.

Pa., Tarentum—Boro of Tarentum, J. F. Conroy, Secy., 304 Lock St., will soon award contract for a 1 story, 30 x 100 ft. addition to electric light and water plant, at 618 5th Ave. Estimated cost $150,000. M. Knowles Co., Westinghouse Bldg., Pittsburgh, are engineers.

Tex., Dallas—Dallas Gas Co., 2016 Jackson St., received low bids for the construction of a 13 story office building, including steam heating system, etc., at Jackson and Harwood Sts. Estimated cost $1,000,000. Lang & Witchell, 300 First National Bank Bldg., are architects. Gardner & Howe, 1429 Kirby Bldg., are structural engineers.

Tex., Edinburg—Hidalgo County Water Improvement District 6, A. L. Cramer, Pres., awarded contract for the construction of an irrigation project to include three pump houses, pumps, etc., to W. R. Briggs & Co., Pharr, $124,911.

Tex., San Antonio — City, c/o J. Rubiola, Comr., awared contract for seventeen refrigerating units for municipal market house to E. Friedrich, East Commerce St. $17,382.

Tex., Tuco—Texas Utilities Co., Plainview, (controlled by American Community Power Co., Planters Bldg., St. Louis, Mo.) is having preliminary surveys made for the construction of a steam-operated power plant here, to use either oil or gas as fuel. Estimated cost $425,000. Private plans.

Va., Winchester — Northern Virginia Power Co., has made application for permit to construct a 6,900 v. power transmission line from substation at Manganese Mine to Wardensville, W. Va.

Ont., London—Kellogg Co. of Canada Ltd., J. R. McKinley, Mgr., Dundas St., is having plans prepared for the construction of a new power house. Estimated cost $150,000. A. Kahn, 1000 Marquette Bldg., Detroit, Mich., is engineer.

Equipment Wanted

Cranes, Oil Burning Apparatus, etc.—Detroit, Mich.—Dept. of Water Supply, D. C. Grobbel, Acting Secy., will receive bids until Nov. 25 for furnishing and installing three overhead electric cranes, power plant type; 230 v. d.c. for power plant, Springwells Pumping Station; also will soon award contract for fuel oil burning apparatus in steam boiler at auxiliary low lift plant, Waterworks Park.

Exhaust Fan — Cambridge, Mass. — New Method Die & Cut-Out Co., 30 Cross St.—24 in. exhaust fan, 550 v., 3 ph. 60 cycle.

Generating Equipment—Pasadena, Calif.—City, B. Chamberlain, Clk., will receive bids until Nov. 22 for steam generating equipment including boilers and appurtenances for municipal light plant.

Pump—Mangum, Okla.—City plans to purchase a booster pump, etc. for proposed waterworks improvements. Estimated cost $108,000.

Pump—Toronto, Ont.—City, B. S. Wemp, Mayor, City Hall, will receive bids until Nov. 25 for the installation of an 8½ m.g.p.d. centrifugal pump and appurtenances for proposed waterworks. Estimated cost $20,000.

Pump and Motor—Rushville, Neb.—City, E. L. Curtiss, Clk. will receive bids until Nov. 20 for a deep well turbine pump and motor, etc. for proposed waterworks.

Pumps—Glens Falls, N. Y.—Dept. of Public Works, E. L. H. Meyer, Water Supt., will soon receive bids for hydraulic water pumps for waterworks.

Industrial Projects

Calif., Avon—Associated Oil Co., 79 New Montgomery St., San Francisco, and 17 Battery Pl., New York, awarded contract for the construction of an oil cracking unit, 10,000 bbl. daily capacity to include equipment, complete installations, etc., near Martinez, to E. B. Bager & Son, 75 Pitts St., Boston, Mass. Estimate cost $2,000,000.

Calif., Sausalito—Italian American Motors Co., 604 Montgomery St., San Francisco, will build a boat and motor plant. Estimated cost $40,000. Work will be done by day labor.

Conn., Bridgeport — Clover Farms Inc., 73 Sedgwick St., plans the construction of a dairy and ice cream manufacturing plant, including electric refrigeration equipment. Estimated cost $200,000. Architect not selected.

Ill., Lincoln—Lincoln Casket Co., W. Dowling, Pres., plans the construction of a 2 or 3 story factory. Estimated cost $75,000. Private plans.

N. J., Elizabeth—Fisher & Dackerman, 1153 Chestnut St., is having plans prepared for a 1 story addition to factory for the manufacture of automobile bodies. Estimated cost $40,000. W. L. Finne, 1201 East Grand St., is architect.

O., Cincinnati—C. R. Talbott Co., 3345 Bogen St. (iron and steel), awarded contract for the construction of a 1 story addition to factory to D. Meinken & Son, Barnard St. Estimated cost $75,000.

Pa., New Castle—Blair Strip Steel Co., G. D. Blair, Jr., Pres., awarded contract for rebuilding steel plant destroyed by fire, 1 story, 50 x 200 ft. at Butler Ave. Ext., to A. W. Bauman, 306 East Winter Ave.

Pa., St. Marys—Spear Carbon Co., D. Miller, Gen. Mgr., awarded contract for the construction of a 1 story, 82 x 119 ft. carbon electrode plant to Rogers Structural Steel Co., Corry. Estimated cost $40,000.

Tenn., Nashville—Tennessee Cereal Co., Independent Life Bldg., awarded contract for a 2 and 4 story flaking mill on Franklin Pike to Wagar Construction Co., Norris Bldg., Atlanta, Ga. $56,000. Contract for power plant, water filtration plant, etc. to be let later. Total cost $150,000.

Tex., San Benito—Etchison Produce Co., 595 Sam Houston Blvd., will soon award contract for the construction of a 1 story, 48 x 200 ft. packing plant including cold storage facilities, etc. Private plans.

Wash., Millwood—Inland Empire Paper Co., awarded contract for a 1 and 2 story addition to factory to The Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $300,000.

Wash., Seattle—A. Kahn, 1000 Marquette Bldg., Detroit, Mich., Archt., will receive bids until Nov. 17 for a 1 and 2 story automobile assembly plant here for Ford Motor Co., 3674 Schaefer Rd., Dearborn, Mich. Estimated cost $750,000. Electric motors and assembly equipment including cranes, conveyors, etc., will be required.

Ont., Gravenhurst—Rainbow Craft Ltd., G. Greavett, Gen. Mgr., will soon receive bids for the construction of a 1 story, 80 x 250 ft. shops and factory for the manufacture of motor boats. Estimated cost $100,000.

Ont., Toronto — Sangamo Electric Co. of Canada Ltd., 179 George St., awarded contract for a 2 story, 40 x 100 ft. addition to factory to J. A. Wickett Ltd., 16 Saulter, St. Estimated cost $50,000.

France — Frefileries & Laminoirs, Havre, France, plans the construction of an electrolytic copper refinery, 30,000 ton annual capacity, under a technical aid contract. Location not disclosed.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

THE declining trend observed throughout September in power-plant supplies appears to have abated during the last month. Prices now are steady with few exceptions. One of these exceptions is babbitt metal. Although the anti-friction alloy has not changed in price from October quotations, there are reductions in the November prices, amounting to 1c. per lb. in the highest and the intermediate grades and ¼c. in the No. 4 grade. Linseed oil, the paint barometer, is off 0.8c. per lb. at New York, compared with the Oct. 14 level. Prices of wire solder nd rubber-covered copper wire tend downward.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket, net, per ft		$0.65
Common, 2½-in., cotton, rubber-lined, 80c. per ft., list, less		50–10%

Air—Best Grade, Net

¼-in., per ft	3-ply $0.30	4 ply $0.36

Steam—Discounts from List

First grade	50%	Second grade	50–5%	Third grade	60–5%

RUBBER BELTING—List price, 6-in., 6 ply, $1.83 per lin.ft. The following discounts from New York warehouse list apply to rubber transmission belting:

Best grade	60%	Second grade	60-5%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses in quantities of about ½ doz. rolls:

Grade	Discount from list
Medium	30-10%
Heavy	30%

RAWHIDE LACING—Cut lacing, best quality, 30-10%; 2nd quality, 50%. Lace leather sides, best, 12-17 sq.ft., 55c. per sq.ft.; 2nd, 48c., net. Giant or Indian tanned cut lacing, 30-10%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts from list at New York warehouses are as follows:

85% magnesia, high pressure		40 %
Asbestos, air cell, for low-pressure heating and return lines	4-ply	65 %
	3-ply	67½%
	2-ply	70 %

PORTLAND CEMENT—New York, $2.10 per bbl., without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.10 per 100 lb. in lots of 400 to 3,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	13.00	16.00	15.00
Colored	9.50	12.00	10.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed white wipers, as follows:

Chicago (100 lb. bales)	$0.14½
New York (100 lb. bales)	.14
Cleveland (per thousand)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Minneapolis	Chicago
Per pound	$0.098	$0.109	$0.106

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b., New York:

	Dry	In Oil
Red	$13.75	$15.25
White	13.75	13.75

RIVETS—The following quotations apply on fair-sized orders from warehouse:

Tank rivets, ⅞-in. diameter and smaller, list (Apr. 1, 1927) less 65% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., round head, per 100 lb.:

New York	$4.50*
Chicago	4.00
Pittsburgh mill	2.75

*This price is for full kegs; broken-kegs are $6.00 per 100 lb.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome ore, ground, 40@50%, Cr_2O_3, in bulk	per net ton	22@25
Chrome ore, ground, 40@50%, Cr_2O_3, in sacks	per net ton	26@29
Chrome ore, crude, 40@50%, Cr_2O_3	per net ton	18.00@22.50
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa	per M	43.00
Clay brick, 1st quality, 9-in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Colorado	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38

BABBITT METAL—Delivered in case lots from New York warehouse, on orders of 100 lb. or over, cents per pound:

Genuine, highest grade	47.00
Commercial genuine, intermediate grade	34.00
Anti-friction metal, general service	30.00
No. 4 babbitt, f. o. b.	10.00

COLD-FINISHED STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.65	$3.35
Flat or square	3.90	4.15	3.85

BOILER FITTINGS—F.o.b. warehouse, Jersey City, N. J., discounts from list:

Copper ferrules	70%
Boiler flanges	65–5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following basing discounts from list are for large mill ots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	64%	52½%	1 and 1¼	31%	15%

LAP WELD

2	57%	45½%	2	23%	9%
2½ to 6	61%	49½%	2½ to 3½	28%	13%
7 and 8	58%	45½%	4 to 6	30%	17%
9 and 10	56%	43½%	7 and 8	29%	16%
11 and 12	55%	42½%	9 to 12	26%	11%

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	62%	51½%	1 to 2	34%	18%
2 to 3	63%	52½%			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	55%	44½%	2	29%	13%
2½ to 4	59%	48½%	2½ to 4	34%	20%
4½ to 6	58%	47½%	4½ to 6	33%	19%
7 and 8	54%	41½%	7 and 8	31%	17%
9 and 10	47%	34½%	9 to 12	21%	8%
11 and 12	46%	33½%			

BOILER TUBES—Standard gage, manufactured in accordance with the specifications and requirements of the American Society of Mechanical Engineers and in compliance with the rules and regulations of the U. S. Steamboat Inspection Service, from New York warehouse stock, per 100 ft.:

Size, Inches*	B.W.G.	Toncan Seamless Iron	Knobbled Charcoal Iron	Seamless Steel	Lapwelded Steel
1	13	$34.00	.....	$18.00	.....
1¼	13	37.75	.....	20.25	.....
1½	13	38.00	$38.00	19.25	.....
1¾	13	30.00	30.00	22.00	.....
2	13	26.25	26.25	20.25	$19.00
2¼	13	34.50	34.50	23.00	25.00
2½	12	34.00	34.00	26.00	24.25
2¾	12	40.50	40.50	28.50	27.50
3	12	42.50	42.50	27.00	25.50
3½	11	50.25	50.25	30.75	28.75
3½	11	54.50	54.50	33.25	31.50
4	10	67.00	67.00	40.00	38.00

These prices are based on stock lengths. If cut to special lengths billing will be based on the entire stock lengths. In addition to the foregoing, standard cutting charges are as follows:

2-in. and smaller.. $0.05 per cut
2½ and 2½ in..... .06 per cut
3-in..... $0.09 per cut
3½ to 4 in.. .10 per cut
*External diameter.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft., New-Style, A.B.C., with fibre bushing:

B. & S. Size	BX Two Cond. M. Ft.	BX Three Cond. M. Ft.	Lead Two Cond. M. Ft.	Lead Three Cond. M. Ft.
No. 14 solid....	$23.37	$38.24	$66.00	$86.75
No. 12 solid....	38.02	50.52	76.00	104.00
No. 10 solid....	52.10	66.22	95.00	124.00
No. 8 stranded..	85.34	105.22	133.00	185.00
No. 6 stranded..	123.58	148.81	180.00	253.00

Coils to 1000 ft., +10%; less than coil lots, +20%.

CONDUIT—Rigid iron, price per 1,000 ft.; **ELBOWS AND COUPLINGS,** per 100 pieces, extra. Delivered from New York warehouse. Discount of 5 per cent for payment in 10 days; 30 days net.

Size, Inches	GALVANIZED Conduit	GALVANIZED Elbows	GALVANIZED Couplings	BLACK Conduit	BLACK Elbows	BLACK Couplings
¼	$60.89	$8.31	$4.79	$55.67	$7.14	$4.36
⅜	77.61	10.94	6.85	70.53	9.41	6.24
1	111.26	16.35	8.94	100.80	14.07	8.14
1¼	150.53	22.47	12.59	136.38	19.71	11.54
1½	180.00	30.05	15.59	163.08	26.35	14.29
2	242.20	54.69	20.87	219.43	47.92	19.15
2½	382.95	90.49	29.81	346.95	79.41	27.34
3	500.80	233.74	44.70	453.72	204.21	41.01
3½	630.74	511.83	59.92	574.14	446.60	55.00
4	769.61	591.84	74.69	702.53	516.46	68.53
4½	896.51	892.12	111.40	818.37	777.99	102.16
5	1045.06	1240.73	122.91	953.99	1082.29	112.75
6	1355.64	1547.71	177.72	1237.49	1350.80	162.95

CONDUIT BODIES AND FITTINGS—Black or galvanized:

	Less Than $15 List	$15 List to $100	$100 List and Over
Standard package	15%	20%	28%
Less than standard package	10%	15%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$15.00
No. 16 cotton reinforced heavy		19.00
No. 18 cotton reinforced light		12.00
No. 16 cotton reinforced light		14.00
No. 18 cotton Canvasite cord		13.00
No. 16 cotton Canvasite cord		15.00
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$64.00	*71.00
No. 14 super service cord or similar (2 wire) in 1,000 ft.	92.00	*101.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List Each
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 65%; standard package, 70%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.....	$0.50	$1.10	100	10
35 to 60-amp.....	1.00	1.25	100	10
65 to 100-amp.....	2.00	3.00	50	5
110 to 200-amp.....	4.00	5.00	25	5
225 to 400-amp.....	7.50	11.00	25	1
450 to 600-amp.....	11.00	16.00	10	1

REFILLS—

1 to 30-amp.....	$0.03 ea.	$0.05	100	100
35 to 60-amp.....	.05 ea.	.06	100	100
65 to 100-amp.....	.10 ea.	.10	50	50
110 to 200-amp.....	.15 ea.	.15	25	50
225 to 400-amp.....	.30 ea.	.30	25	25
450 to 600-amp.....	.60 ea.	.60	10	10

Discount Without Contract—Fuses:
Broken cartons..... Net list
Unbroken cartons..... 17%
Ten unbroken cartons..... 34%
Discount Without Contract—Renewals:
Broken cartons..... Net list
Unbroken cartons..... 17%
Ten unbroken cartons..... 34%
Discount With Contract—Fuses:
Broken cartons..... 5%
Unbroken cartons..... 20%
Ten unbroken cartons..... 36%
Discount With Contract—Renewals:
Broken cartons..... Net list
Ten unbroken cartons..... 36%
Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package (500), per 100	$2 50
0–30 ampere, less than standard package, per 100	2.75

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt Watts	General Type	Price Each	200—260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.20	...	....	.....
60	A 21	.20	...	....	.....
100	A 23	.35	...	....	.....

Carton quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.06

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f.o.b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$4.75	$6.50	$7.10	$13.20
12	6.90	8.00	9. 0	17.90
10	8.45	10.40	11.80	22.50
8	13.00	15.00	17.15	32.00
6	.....	.....	23.00	.....
4	.....	.....	34.00	.....
2	.....	.....	47.00	.....
1	.....	.....	70.00	.....
0	.....	.....	83.00	.....
00	.....	.....	95 00	.....
000	.....	.....	117.00	.....
0000	.....	.....	142.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	⅛ In. or Pendant Cap Key	Keyless	Pull	¼ In. Cap Key	Keyless	Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—
Friction tape, ¾ in., in less than 100 lb., 30c. per lb.; in 100 lb. lots, 28c. per lb
Rubber tape, ¾ in., in less than 100 lb., 32c. per lb.; in 100 lb. lots, 29c. per lb
Wire solder, in less than 100 lb., 28c. per lb.; in 100 lb. lots, 26c. per lb.
Soldering paste, 2 oz. cans..... $1. 10 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.:

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$3.50	$5.70	$9.00
60	9.00	11.00	14.00
100	14.00	17.00	29.00
200	22.00	29.00	48.00

Discounts:
Standard package..... 40%
Less than standard package..... 35%